

EXE

OCTOBER 1992 VOL 7 ISSUE 5

£3.20

The Software Developers' Magazine



*Go to the ant - consider her ways!
Tools and techniques for working together.*

*Order your project with Version Control.
Three competing systems compared.*

*It's too fat, too slow, too pricey -
So Patrick McParland seeks economy CASE.*

Laine Stump's multi-vendor Windows control.

*Mastering the details of TIFF files.
We have full Graeme Webster with source.*

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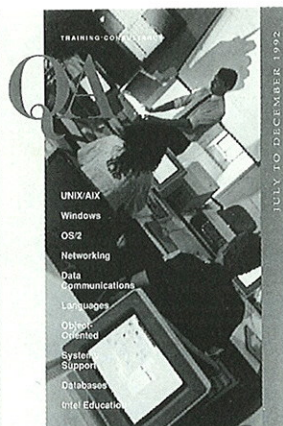
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Editorial enquiries should be addressed to The Editor, .EXE Magazine, 10 Barley Mow Passage, Chiswick, London W4 4PH. We welcome letters, opinions, suggestions and articles from our readers. Please write for a copy of our Contributors' Guide.

Information contained in .EXE is believed to be correct. If errors are found, we will endeavour to publish a clarification in the next available issue.

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.EXE Magazine rhymes with 'not sexy magazine'.

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Issue theme: Working Together

BIG BROTHER

There's more to source code control than PUT and GET. Cliff Saran evaluates three version control systems.

16

THE NEED FOR LOW COST CASE

Big CASE tools are bought only by big companies. It's time to give the little guy a go, says Patrick McParland.

24

AWARD YOURSELF VC

Version Control may be rather lacking in glam, But Malindi Lamb thinks it's time we all used it.

30

TIFF FILES: HOW TO READ AND WRITE THEM

Are your bitmaps in a TIFF? Graeme Webster can put them there.

33

A CHOICE OF WEAPONS

Thomas Payne compares two Window OOPLs - neither is C++!

42

TERMIO BLUES

Great for Terminals, less great for modems. Richard Samworth tinkers with UNIX's async drivers.

51

SOAPBOX

Potential perils of too much documentation.

4

NEWS

Industrial espionage! Borland sends the FBI after Symantec.

6

LETTERS

A tear-jerker from abroad, the Editors strike back.

12

MAYHEM

Julius adsum jam forte...

58

LAINE STUMP'S C++ DIARY

Laine battles with two custom control specs.

60

xBASE

Give your users QBE with Guy Smith's SuperClass object.

68

UNIX REGULAR

Alain Williams tries SCO's new release of Open Desk Top.

72

ECUG

Don't confuse C++ with OOP: Mike Banahan discusses a problem with inheritance.

76

CROSSWORD

Another puzzle from ace crossword-smith Eric Deeson.

78

CUG

Four C pitfalls from Francis Glassborow.

78

BOOKS

Billionaire Bill's secrets, and Yourdon gets gloomy.

80

SHAKESPEARE ON PROGRAMMING

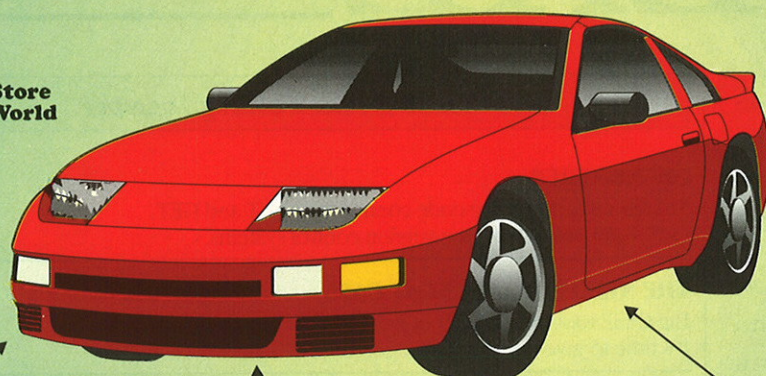
Guest columnist Wysiwyg reinterprets our greatest writer.

88

Does the Real World fit your Database, Or your Database fit the Real World?

Problem :

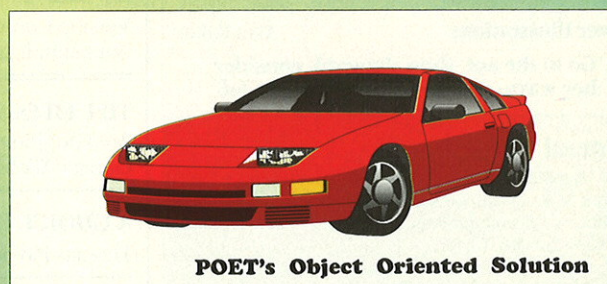
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Object Oriented DBMS v Relational
Relational Database (RDBS) and B-Tree/ISAM systems require that data be portrayed as a series of two dimensional tables. These systems were a real breakthrough in their time, but software developers are rapidly learning that life is not a series of two dimensional tables.

For example, a CAD program might have an array of shapes, or a DTP program might model a page as a series of frames which might contain bitmaps, paragraphs or vector drawings. Conventional databases have a fixed set of data types. And the only way they group data is in a table.

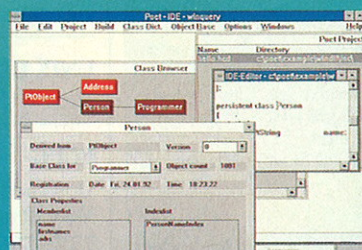
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Tangled Thread

'Underlying every Software Engineering principle is a good idea, or at least the ruins of a good idea. Is this enough?' Discuss.

The low water mark of my programming career came in the autumn of 1986. Having had my dot matrix-printed 'Threads' document approved by the inspection committee, I deliberately and childishly spilled a mug of coffee over it in an attempt to force my Enemy, the Project Librarian, to reprint FFDI-1887/ded/WRW.2.7 (as it was called) 'nicely' on the laser. The Librarian was having none of it, and it was my blotted copybook that she filed in the Project Cabinet where, I dare say, it rests to this day.

If you have never experienced rampant Bad Software Engineering, you may have some difficulty in understanding how I came to this 'Bridge Over River Kwai' state of mind. (You will recall that in 'Kwai' an English POW officer, forced by the Japanese to build the eponymous bridge, becomes obsessed with completing it to perfection and fatally loses sight of its purpose.)

A 'Thread' in this context is one possible path of execution through a block of code. For example: a routine comprising two independent IF statements is blessed with four Threads: both IF conditions False, IF1 True IF2 False, IF2 False IF1 True and both True. You get the idea.

My Threads document described one code module, equivalent to 70-100 lines of Pascal. The programming involved was trivial; there was nothing sufficiently tricky in it to merit the epithet 'algorithm'. A little data validation, a few error messages to put out - say an hour's work on a good day. Each Thread required its own number, a data flow diagram, and an English language description - a short story with a dull ending. 'Thread 27b. 1) The routine is called with Parameter X equal to 4, and the global ERR_STAT_GLOB_LHS equal to ERR_STAT_CLR_CONST. 2) The routine tests ERR_STAT_GLOB_LHS. 3) The routine returns. 4) No action is taken.'

Conscientious idiot that I was, I found about 60 Threads in this module. It was slow work. After three days of writing/drawing them up, I ached for a more intellectually challenging and satisfying task, like washing up. The only way I managed to finish that document was by going Kwai: I'm going to do this thing perfectly - as a piece of spite to mock the stupidity of the people who are making me do it.

It is easy to deduce the thinking that misled the Company to believe that Threads were useful. 'To produce Quality Software', says the ruins-of-ideas merchant, 'you must document every detail

at every stage in baby talk, so that all ideas and components of a project are communicated and are traceable and are accessible by any member of the project who might need them. Go forth and write your Threads, and hang the time and the expense.'

But can you spot why the technique is intrinsically a load of spit? For here is the central paradox of bad Software Engineering. In order to be able to describe a module properly with a series of

Threads, you must understand it completely. If you *do* have a complete understanding of the module, then the document is useless to you, a dangerous (because it is likely to be wrong or incomplete) duplication of the code. You will quit, or fool around and indulge in petty coffee-spilling sabotage, or get promoted (all of these happened to me). If you *don't* have a complete understanding of the module, you shouldn't be writing the Threads. You probably shouldn't be a programmer - but you will do it and like it, for what is one more incomprehensible task in a working life full of incomprehensible tasks?

So bad Software Engineering practices attract, by a process akin to evaporation of alcohol from

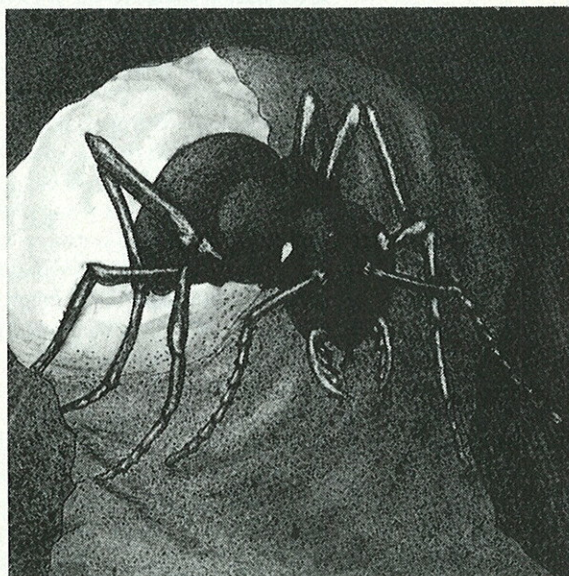
water, bad programmers who, in turn, create bad software which is badly documented.

'What then, Mister Clever Clogs, is a Good Software Engineering technique?' Apply the same simple rules as when evaluating a piece of user software for your own use. The cost of using it must be outweighed by its beneficial effects. These beneficial effects should be felt by the people practising the technique, as well as QA people. The technique must be simple to use. It must increase the possibilities of what can be done, not limit them. Some boredom is permissible; *futile* boredom is unforgivable. Always test against Occam's razor. Try 'programming by contract' for an example which meets these criteria.

To end the story: I fled to another job (with sighs of relief all round, I dare say) shortly afterwards. I don't know if the Company, obsessed with enforcing its regime of documents, ever grasped why it cost so much to produce so little, poor-quality software. Perhaps it did have an inkling. The practice of documenting Threads survived me, but was abandoned the next year.

EXE

Will Watts edits this magazine. He won't tell us where he was working in 1986.



Summer '87 to C

Sequiter Software has upgraded its Code Translator product for converting xBASE applications to C. Adding to the dBASE III and III+ support in the previous release, V2.0 provides explicit support for Clipper Summer '87. Output is ANSI-compliant C which the company says will compile with most popular compilers including Borland C++ V3.1 and Microsoft C/C++ V7.0. In addition to the command-line product, Sequiter has provided a simple DOS text-based front-end to Code Translator. Code Translator costs £149 and is distributed in the UK by The Software Construction Company on 0763 244114.

DPMI for R:Base

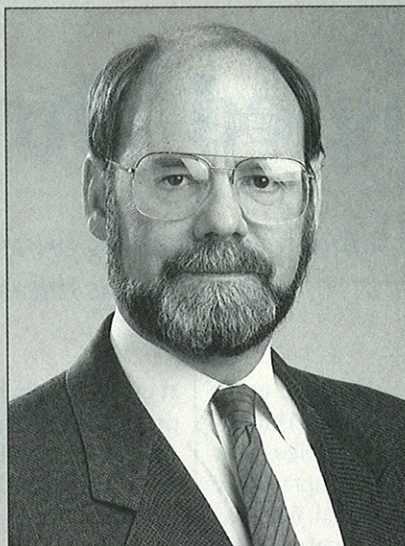
Microrim claims that it has produced the first DPMI-compliant relational database. This takes the form of R:Base V4.0 which offers ANSI Level 2 SQL and a new Code-View-like debugger with mouse support and multiple breakpoints. The company says that this release is up to 12 times faster than previous versions, especially transaction throughput on networks. Recent benchmarks conducted by InfoWorld suggest that transaction processing has been improved by an order of 134%. The 5-user version retails at £895. Phone Microrim on 0344 869123 for details.

WCL

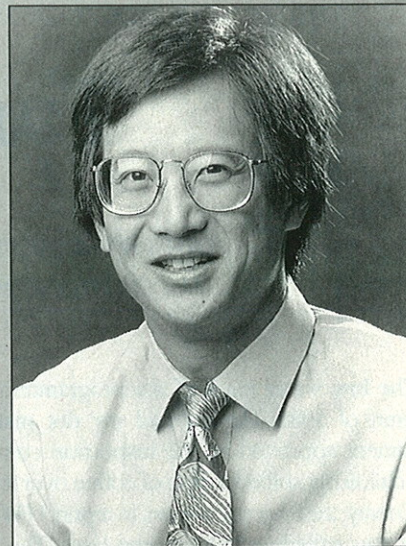
Jules May's Catullus language (see this month's Mayhem) may be fictional, but his WCL Windows graphical language is real. Mr May says that his language greatly eases the design and implementation of GUI programs, and he has now prepared a demonstration version of it, which can be obtained from the window/wcl conference on CIX, or by sending us a disk under the usual rules given on Page 3 Col 1. Mark envelopes 'WCL'. You'll need a copy of MS C 6.0/7.0 and a Windows 3.0/3.1 SDK. Jules Computer Ltd is on 071 609 9677.

dBFast Charting

Bits Per Second is now offering a version of ChartBuilder for Computer Associates' Windows-based dBFast database. ChartBuilder brings charts and graphs to dBFast and enables developers to write .PRG procedures which include ChartBuilder commands. The output from ChartBuilder may be displayed in a separate window or hardcopy can be produced using dBFast's printing facilities. The package includes a royalty-free copy of Graphics Server, the run-time graphics engine used by ChartBuilder. ChartBuilder for dBFast retails at £49. Bits Per Second is on 0273 727119.



Eubanks: Received MCI secrets



Wang: Role played down

Borland accuses Symantec of theft

Borland International has accused an ex-employee and Symantec Corporation of industrial espionage, and has caused a criminal investigation to be undertaken by the police and the FBI.

Borland alleges that Eugene Wang, its former vice president and general manager of languages, on several occasions transmitted 'highly sensitive confidential business information' via MCI Mail to Gordon Eubanks, CEO of Symantec. American PC Week reports that Borland officials accessed Wang's MCI account shortly after his departure and found at least 10 such messages between Wang and Eubanks.

According to its own press release, Borland filed a civil lawsuit against Wang, Eubanks and Symantec, although CEO Philippe Kahn subsequently denied suing Wang. A criminal investigation followed, with police raids on Symantec's premises and the homes of Wang and Eubanks.

All this occurred the day after Symantec had announced the appointment of Wang as executive vice president of Development Tools and Productivity Applications. As manufacturer of the Zortech C++ compilers, Logitech debugger and Whitewater development tools, Symantec is a close rival of Borland. Commenting on the Borland's action, Robert Dykes, Symantec's VP of worldwide operations, said 'We believe that this is an attempt by Borland to inhibit others from hiring Borland employees. This activity is clearly calculated to create publicity and harass.'

During his time at Borland, Wang was noted for a very aggressive and individual style, for example whipping up delegates at a Borland C++ conference into a frenzy of anti-Microsoft sentiment. Borland now seems to be trying to play down the importance of Wang's role at the company and in the affair, although in view of the nature of the allegations it is difficult to see how this can be done.

386 RTOS Toolkit

VRTXvelocity DOS/386 is a new development environment for Ready System's VTRX32 32-bit real time operating system. The package includes RTsource 386, a multi-tasking symbolic debugger for C which provides single stepping and conditional breakpoint together with multiple windows for displaying source code, memory dumps and registers. Connection to the host PC is via a 115,200 baud serial link. A board-level monitor called RTscope provides developers with the facility to download/upload code to a target system, set kernel-level breakpoints and view the status of the operating system, including the task list and queues. VRTXvelocity comes with a reentrant C run-time li-

brary and supports several third-party development tools including Metaware High-C V1.73 and Phar Lap 386/ASM. The package also contains a copy of the Phar Lap DOS/386 extender.

Other features include WIX (a windows manager) and GFX, a graphics support library which enables developers to create applications targeted for the PC with support for VGA, EGA, CGA and monochrome display adapters. It also provides an implementation of TCP/IP (TNX) for network-independent communications and IFX, a device-independent I/O Manager with a hierarchical file system and disk caching. The VTXvelocity DOS/386 development environment retails at £7891. It is distributed in the UK by Instrumatic on 0628 476741.

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Super-duper TCP/IP

Super-TCP is a new Windows-hosted connectivity tool from Diamond Point which enables end-users to access to TCP/IP networks. The product features multi-document E-Mail and support for NDIS drivers and NFS. The company says that it also has a real time 'chat' facility and support for several concurrent TELNET sessions. Super-TCP costs £345. Phone Diamond point on 0634 722398 for details.

Mac Attack

A market report commissioned by Apple, Claris and Microsoft gave evidence of an alarming increase in the piracy of Mac software in the UK. The survey, conducted by the Ashdown Group, estimated losses of well over £20 million per annum - or to put it another way, for every legal copy of Mac software there is an average of 1.34 copies of illegally obtained software. The report has been published by FAST, on 0628 660377.

Windows Over-Drive

DFI Inc has introduced two low-cost Windows accelerator cards. The VG-8000W supports 640x480, 800x600 and 1024x768 screen resolutions in 256-colour mode. The VG8000WH additionally offers 1024x1024, 1024x960 and 1280x1024 resolutions in 16-colour mode. DFI says that both 16-bit cards increases the performance of Windows by up to 16 times. The retail price for the VG8000W card is £119 and £135 for the VG8000WH card. DFI is on 081 4612322.

Hare & Tortoise

With a sense of achievement, IBM proudly announced it had shipped the one-millionth copy of OS/2 V2.0. Not to be outdone, Microsoft counter-attacked by claiming it was shipping over one-million copies of Windows 3.1 PER MONTH. Will Windows run out of steam? Will OS/2 pick up momentum? Watch this space.

Talk Windows

Microsoft has introduced a new 16-bit audio card for Windows called the Windows Sound System. It comes complete with a microphone, headphones, and simple speech recognition software which lets a user speak Windows commands such as 'File Open' instead of using a mouse. Sound System is incompatible with other sound cards such as SoundBlaster. It will be available in November and retail at £199, or £249 bundled with Windows 3.1. Microsoft is on 0234 270001.

MOT for RDBMSs

SysData has developed a suite of tools for keeping relational databases in check. The complete package is called CheckMate and includes tools for determining the logical relationships between tables, a test data generator and a program generator for producing common scripts such as Cascade Delete or Archive Data. A key component, SmartCheck, is used to validate data in RDBMSs. This works by creating scripts to check table relationships and column data. SmartCheck generates reports and produces script files for repairing damaged tables. SysData says that running SmartCheck on a RDBMS should guarantee production data obeys the design relationships. It can also be used during system testing to determine whether the database behaves as expected when presented with test data. CheckMate costs £4,000 from SysData on 071 3719191.

BASIC for GIS

Now AutoRoute is a brilliant bit of software. Haven't you ever dreamt of writing something similar? Well here's your chance. All right, I'm being a little optimistic, but a new language called MapBasic, from MapInfo Corp, may well put you on the right tracks. The company says that its product is the first to enable users to customise mapping applications using an enhancement to the BASIC language which includes an extended version of embedded SQL. The extensions to SQL provide such facilities as Within, Intersect and Contains for querying geographic databases. For instance, these queries enables developers to write applications which report all customers who are based in a given territory boundary (eg postal area). MapBasic works in conjunction with the company's MapInfo V2.0 product which is available for several platforms including Windows, Macintosh and Sun. The MapBasic Development Environment costs £600.

Speedy R&R

R&R Software has upgraded its existing range of products with new releases of R&R Report Writer and R&R Code Generator. Improvements in Report Writer V5.0 include the addition of a data dictionary, ability to output reports in .DBF and .WKS formats, mouse support, and a Run-Time Query and Page Preview facility. The company also claims that V5.0 now 10 times faster than V4.0 and supports more database file types. V5.0 of R&R Code Generator is an add-on to Report Writer which generates code for dBASE, Clipper and Fox-compatible databases. R&R Report Writer V5.0 retails at £169, with £75 for upgrading from V4.0. R&R Code Generator V5.0 costs £149 (£55 for upgrade). Phone R&R Software on 0628 788181 for details.

Shareware C/C++

GNE C/C++ Utilities is a suite of seven programming tools from GNE Software Ltd. A Source Printer provides double-sided printing and printing more than one page per sheet, which the company says allows up to six pages of legible source to be printed on a single sheet. The Source Printer also provides an index which gives the page number of function definitions, headers, footers and keyword highlighting in bold print.

Printer support include PostScript, LaserJet and Epson-compatibles. Other features of GNE include a Source Reformatter using user-supplied indentation styles, a Function Prototype Generator and a Code Documentor which extracts special commented text from source files to create alphabetically ordered function/data structure documentation. A Call Tree Viewer enables developers to trace the history of which functions a given routine invokes or what function it is called by. GNE C/C++ is available as a Shareware product. Registration costs £35 from GNE Software on 0582 768341.

First NT Framework

Inmark says it has beaten everyone to the mark with the first third-party application framework for Windows NT. Howard Love, President of Inmark added, '...we are the only vendor to provide true single source compatibility with Windows NT, Windows 3.X, and DOS for cross-platform development.' zApp for Windows NT needs the MS C/C++ compiler that comes with the Windows NT SDK. Inmark says that support for other compilers will be added as and when they become available. zApp for Windows NT costs \$395 and includes full source code.

Inmark has also announced minor upgrades to its zApp for Windows and zApp for DOS application frameworks. zApp for Windows V1.1f comes complete with several example programs to demonstrate some of the trickier features of Windows such as Drag-and-Drop and the use of Borland Custom Controls in Dialogs and Forms. Improvements to zApp for DOS V1.1f provides better source code compatibility with zApp for Windows. Inmark charges \$10 for each upgrade. Phone 0101 415 6919000 for details.

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SDK for DESQView/X

In an attempt to steal some limelight away from NT and OS/2, Quaterdeck is pulling all the stops to spread the word on the recently introduced DESQView/X system. On the heels of the Santa Monica Developer's conference in August, and having announced that a European conference is in the pipeline, the company has released a number of SDKs for DESQView/X. The X11 toolkit gives developers access to scalable fonts via Adobe Type Manager, and the ability to create X client applications. The toolkit also includes an implementation of the Berkeley Socket Interface for network-independent communications, and allows developers to access DLLs, remote printing, and virtual memory provided by DESQView/X. As an added incentive, a Starter Kit is available which includes the GNU C/C++ compiler, the X11 R4 programming libraries and the X System libraries at a cost of \$50.

The complete X11 Toolkit adds support for several C and C++ compilers (including MS C and Borland C++) and includes Oxygen, the Instant C development environment, and Quaterdeck's Developer Passport support. The Toolkit costs \$750. Phone Quaterdeck on 0245 496699 for details.

Power to Windows

Turbo Power's Win/Sys is a new Windows DLL for Borland C++, Microsoft C/C++ and Turbo Pascal for Windows which provides developers with string, date/time manipulation routines, huge arrays of up to 64 MB in size, and a number of container classes including stacks, queues, binary trees and hash tables. There is also a non-recursive Quick Sort routine and DPMI access to TSRs or DOS memory from within Windows. Additional DOS support includes access to BIOS and DOS environment variables. Win/Sys also provides built-in error-trapping for run-time errors such as Divide-by-Zero or General-Protection-Fault. A Heap Analysis tool is included which generates reports showing memory usage during execution of an application. Win/Sys is priced at \$149 and includes complete source code and documentation.

Turbo Power has also released another Windows development tool. The Data Entry Workshop for Borland's Resource Workshop enables developers to create forms with validated data entry interactively. The library supports all standard C++/Pascal data types and also includes 'hooks' for user-defined types. A utility called Makesrc converts the forms into Pascal/C++ source using a source code template that can be modified by the developer. The new data-validated controls appear as objects which can be accessed from the Borland Object Windows Library application framework. Data Entry Workshop supports Turbo Pascal for Windows, Borland C++ and Turbo C++ for Windows. It retails at \$189 and includes complete source code. Turbo Power is on 0101 719 2609136.

Events for SuperBase

Version 2.0 of Superbase, the Windows-hosted RDBMS from Software Publishing Corporation (SPC), has been shipped. Enhancements to Superbase's programming

language, Super Basic include Visual Basic-like event-handling, user-defined functions and an improved editor with online Help. V2.0 also supports Windows 3.1 features such as OLE, and MCI and it can import/export to Paradox and dBASE databases. There is also a new BLOB (Binary Large Object) facility. The Developer's Edition of Superbase includes a new release of the Superbase SQL Library (V1.1) which enables data to be exchanged with several SQL engines including Oracle Server, Microsoft SQLServer and Gupta SQLBase. The rapid application development environment has been enhanced to include point-and-click Query-by-Example and a macro recorder. The price of the Developer's Edition is £995, and includes Superbase SQL library V1.1, Superbase Run-Time System and an unlimited licence to distribute Superbase run-time applications. SPC is on 0344 867100.

BC31/C7.0 Debugger

Only months after the July buy-out of MultiScope Inc, Symantec has announced MultiScope debugger V2.0. This release of the Windows-based C++ debugger provides support for Borland and Microsoft C++ compilers. Along with a Windows-hosted GUI and C++ name unmangling, other features of MultiScope include object-oriented breakpoints for specifying breakpoints on C++ methods directly, and a class browser. It fully supports C++ expression evaluation and enables the programmer to navigate through the source code using the Class Browser to select member functions to view.

In addition to providing run-time debugging support, MultiScope includes a post-mortem debugger called the Crash Analyser System. At £499, Multiscope is targeted at the higher end of the market. Symantec is on 0628 776343.

Local Heaps

Library Technologies' C-Heap, featured in .EXE April '92, is in its third release. V3.0 adds local heaps and additional expanded memory routines to the memory management facilities offered by previous releases. The company suggests one usage of local heaps could be to store a given instance of a C++ class. The local heap can be swapped in and out of conventional memory to make room for other objects. C-Heap V3.0 costs \$229. Library Technologies is in the US on 0101608 2744224.

CIX without tears

There are three big drawbacks to electronic conferencing systems: they are expensive, their archaic user interfaces are clumsy and hard to learn, and a huge proportion of their content is self-indulgent, cliquish tosh. WIGWAM for CIX, from Ashmount Research, is a Windows program which addresses the first two of these problems. WIGWAM is an 'Offline Reader' - it downloads all your messages in one go, and holds them in indexed files on your hard disk. All message reading, editing etc can take place offline (= for free) using WIGWAM's pleasant user interface. It also handles file up/downloading, and seems to provide access to all the CIX features that one could wish. The price is £145, Ashmount Research is on 071 935 7712.

PC X-Server

NCD's PC-Xview enables networked PCs to be run as colour X terminals. The latest release (V4.0) of this X windows system server supports PathWorks from Digital, giving users concurrent access to DECnet and TCP/IP. Other new features include support for XGA and local windows management which the company says provides better performance. PC-Xview costs £350 per user and is distributed in the UK by Unipalm on 0223 420002.

How much, squire?

It's not easy estimating the cost of producing an application for a customer. General Electric (US) has come up with a tool to help. Called Price S, it takes as input several factors including the magnitude of the project, complexity, the ability to reuse existing code, and outputs cost reports, schedules and a cost risk analysis. Price S is available for MS-Windows and OSF/Motif. A single user annual licence costs £9500. It is marketed in the UK by Price Systems on 0256 760012.

Letters

We welcome short letters on any subject that is relevant to software development. Please write to The Editor, .EXE Magazine, 10 Barley Mow Passage, Chiswick, London W4 4PH. Unless your letter is marked 'Not for Publication', it will be considered for inclusion in this section.

A Change of Address

Dear Mrs Adams, (*Mrs Adams runs our subscription database - Ed*)

Three years ago, in June 1989, I wrote to you to cancel my subscription to .EXE magazine. I explained that the subscription rate for your magazine was 40% of my monthly income. You generously offered me a free subscription to .EXE until my financial situation improved. I accepted, hoping that it would be for a year, or, at worst, two.

A year later, the first free elections came, and the rest is history. I must admit that I never thought I would experience a war in my life. I have been very lucky: my family has not suffered any loss, and our home has remained intact. The front stopped near Novska. Kutina, a town of about 25,000 people, is 30 kilometres from Novska towards Zagreb. Apart from the numerous air raid warnings and two aircraft attacks (the first on 31st October killed two people, the second destroyed a factory on New Year's Eve), our town has been untouched by the fighting.

But one of the many consequences of the war has been a fall in the standard of living. I now earn about £35 per month, which isn't even enough to cover one year's subscription to .EXE magazine.

I have now received .EXE free for three full years. Because of this, I have to suggest that you stop sending me your magazine until I can afford to pay, and that could be a while. Also, if you feel that the duration of my free subscription was too long, I will gladly pay whatever you think is due. You will have to send me a bill, since the bank won't allow overseas payment without an invoice.

Finally, I must inform you of a change to my address. I now live in the Republic of Croatia, not Yugoslavia.

Zlato Smrcek
Kutina

Republic of Croatia

Needless to say, Mrs Adams will not be issuing any retrospective invoices, and hopes to persuade Mr Smrcek to continue his free subscription. Sorry for the self-ad-

vertisement, but I thought this letter might help put the recession in perspective - Ed.

Nintendo returns

Sir,

With development work in even some large IT departments having ground to a halt, perhaps the recession will provide a silver lining in the form of giving IBM breathing space to try for 'third time lucky': OS/2 V3.0. V2.0, like V1.0, requires either inordinate reliance on a third-party CASE vendor or use of a tax loss acquisition to develop any significant software.

It is certainly a pity that no silver lining has appeared in the form of flushing out of the computer industry those who send hate mail, which I was sorry to hear you received after publishing my 'Nintendo' letter (*.EXE, April '92*) directed against C(ult) programmers and Windows fetishists.

Roland Hitchcott
Hampshire

Windows Editor #1

Sir,

I was surprised and disappointed by the tone and contradictory style of Jules May's review of Windows editors in the September issue of .EXE magazine. I venture to suggest that Mr May's opinion of ED is far from representative of the vast majority of users, and other reviewers for that matter.

First, response from our many hundreds of customers could not be any more positive. Furthermore, ED for Windows has just won the PC92/PC Week 'Best New Software Award' for 1992 and in the same week received very good reviews in both *PC Week* and *Windows Tech Journal*. Of course, Mr May does make some valid criticisms, and a new release is due out in September addressing some of his comments and adding new functionality.

In closing, I feel that if there was one thing the article accomplished, it was to prove that the only good editor in the author's eyes was likely to be one he wrote

himself. In my view it was a questionable article to be printed in a magazine I usually regard to be of the highest standard.

Neville Franks
Managing Director
Soft As It Gets P/L

Windows Editor #2

Sir,

I have just read Jules May's review of Windows editors in your September edition, and I would like to point out several careless, factual errors.

'Although the [ix] standard installer didn't set it up... you can add another menu item to handle folds...' On the utilities menu are the options; fold, fold all and unfold all, all installed by the standard installer. As Mr May so rightly points out, this is not in exact agreement with the manual, but they are readily available in ix's standard configuration.

'Smart indenting cannot be switched off (and is brain-damaged)...' The standard indentation assigned to the return key is the editor function EditKRSplitLine after the style of Kernigan and Ritchie (which might not be Mr May's style but is certainly not 'brain-damaged'). It can be changed for EditMJSplitLine or turned off completely by using EditSplitLine.

'Ix (sic) won't compile [using a third-party compiler] at all (despite having a menu item to do so)...' When this menu item is highlighted the status bar reads 'Compile the current (AdHoc) file' which it does without problem. One can only expect menu items to do what they are designed to do.

'Since there's no keystroke to get to the left margin, there's no statement to do it either.' home moves to the first non-blank character on a line and ctrl-home moves to the very start of a line and there are statements for both. And further, there are, in fact, many editor functions which are not merely menu items 'given a name and stuck in the language'.

'You can't find out if there is a selection...' The obviously named EditIsSel func-

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Run with The Fox

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Running an xBase System under UNIX

Implications of porting an xBase application from a single tasking operating system to the more advanced and flexible world of UNIX

Designing for Multiple Back Ends using objects

How to design a systems, using objects, with the ability to talk to DBFs, SQL, Btrieve and other database management systems.

Setting the ANSI xBase standards

The complications and the implications will be discussed.

The Future of Clipper

Now 'Under new Management', will Clipper's development follow the path set out by Nantucket? What new features and functionality can we expect?

Extending the dBase Language

Borland's strategy for the dBase of the future and the xBase standards. Including how to make the best use of the existing dBase language with a discussion on programming techniques.

Wednesday 25th November - Stream 1 - Technical Object Oriented Development

Essential Techniques for Object Oriented Design

Presents a set of techniques with a consistent and fully object-oriented interpretation, building on familiar notations and ideas with a completely practical focus.

Object Based Design in SSADM

The first step towards object-orientation for transaction processing, enabling major business systems to be re-written as integrated and flexible sets of applications.

Object Oriented - The Missed Opportunity

O-O is a general problem-solving technique that has short-sightedly been used for software development, when it can be used for general business problem solving: corporate business modelling, human task modelling and more.

Object Oriented Metrics

Implementing OOP raises project management issues like planning, control and estimating within an evolutionary life cycle. Therefore new methods of measurement are necessary to predict design and coding effort.

O-O Analysis & Recursive Development

O-OA/RD provides a uniform approach to the analysis of problem domains and architectural domains by aiding the selection of a global set of rules rather than the adaptation of individual code modules.

OOP on a Palm Top

A case history of Psion's experience in implementing class libraries and in writing applications using OOP.

Wednesday 25th November - Stream 2 - Management Effective Development for Distributed Processing

Choosing a 4GL

The concepts and benefits of using 4GLs in commercial software development environments. An overview of some leading products highlights the benefits and pitfalls of each product and how these relate to the users.

Version Control & Configuration Management

An overview of version control and configuration management, relating them to current practices in development management.

Choosing a Client Server System

This presentation aims to define both the business benefits from Client Server computing, and the important decisions in their implication.

Is Client Server Computing Ready for Prime Time?

Assesses the current state of client server technology and its readiness for 'prime-time' use by developers, as a platform for RDBMS, LAN use etc.

Getting your VAX together

Project management is an undervalued and under-used discipline. This talk examines techniques such as critical path analysis and resource scheduling and discusses the impact of Project Management.

Quality Assurance - Modern Techniques

QA is not a dirty subject. Using QA techniques can ensure that you produce consistently good, easily maintained code.

Wednesday 25th November - Stream 3 - Technical OS/2 Development

Developing OS/2 Workplace Shell Objects

Programming with the System Object Model (SOM) to develop class libraries and object-oriented programs.

Introduction to the Presentation Manager API

Focussing on PM API functions found in OS/2 2.0 and a discussion of 32 bit migration calls.

Overview of OS/2 Development Tools

Looking at the variety of tools available, particularly those for which 32-bit announcements have been made.

OS/2 As A Development Platform

What does OS/2 2.0 offer as a development environment? The advantages of using OS/2 even for development for other platforms.

Cross platform development with OS/2 2.0

Exploring issues, techniques and advantages of using OS/2 as the development platform for all environments.

Designing OS/2 Applications

Writing good programs for OS/2 requires a new way of thinking, but in the long run it will be easier than developing for DOS.

New Presentation Manager Features

New object types are discussed and demonstrated together with programming examples. We will show you how PM provides an object oriented programming environment beyond the visual elements of an application.

Thursday 26th November Stream 1 - Technical Open Systems & Networking

Licence Management for Open Systems

The use of Licence Managers and their integration into applications to ensure that both the customer and developer benefits are maintained.

Choosing a 4GL for Open Systems

How a system-specific 3GL user can choose between apparently highly similar 4GLs for an open system.

Networks and the Client Server Architecture

The applications of client/server systems, how to integrate them into existing networks and their impact on data strategy.

Security and Risk Management .

Maintaining security over disparate open systems.

Inside LAN Manager

The current and future direction for LAN Manager, and how it fits into an enterprise wide networking strategy.

Distributed System Management

Maintaining a wide-scale system, including data concurrency and access control. What tools are available to manage these systems?

Gupta's SQL System -

Delivering Client/Server solutions.

Designing and maintaining a SQL database system, and how it can be used to provide multi-platform data access.

Thursday 26th November Special Session Basic User Group Conference

VB 2 Presentation

A first look at the latest version of Visual Basic for windows. Also some insights into Microsoft's plans for future versions of Basic under both DOS and Windows

Porting between VB for DOS and VB for Windows

what features should you avoid, and which ones should you use in order to write code that can be easily transferred between the two versions of Visual Basic

Increasing Speed and decreasing code size

Tips and tricks to help keep your .EXE files as small as possible whilst creating the most efficiently coded programs.

Extending Visual Basic

Using VB to front-end both Windows and DOS applications, using DDE, OLE and calls to .DLLs

Linking Basic with other languages

How to have your cake and eat it. Everything you need to know to link routines created with C, Turbo Pascal, Assembly language and other languages into your Basic program.

How to write Libraries and Add ons

Writing and managing .LIB, .QBL and other library files to help you make the most efficient use of the Basic environment without having to re-invent the wheel.

Debugging Basic Programs

How to use CodeView, Turbo Debugger, SoftICE and Basic itself to prevent and detect errors in your programs.

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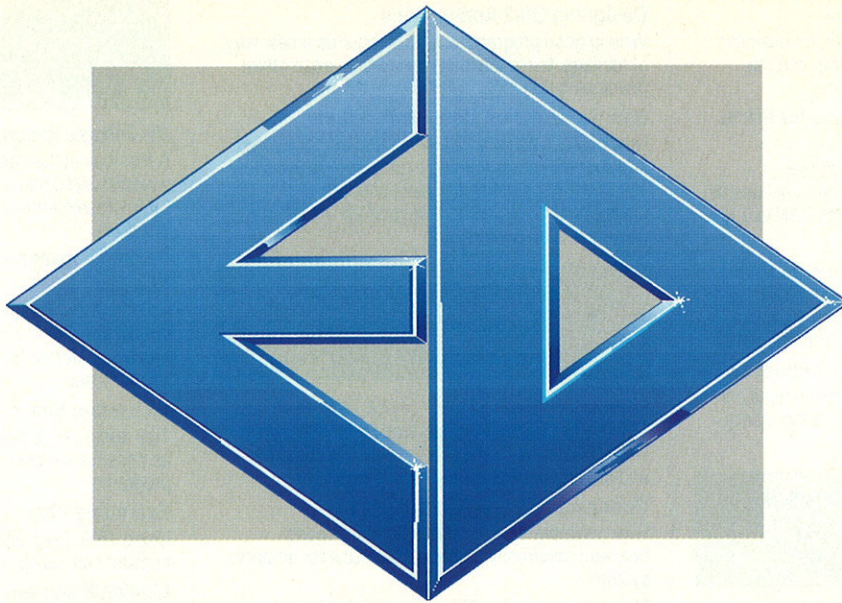
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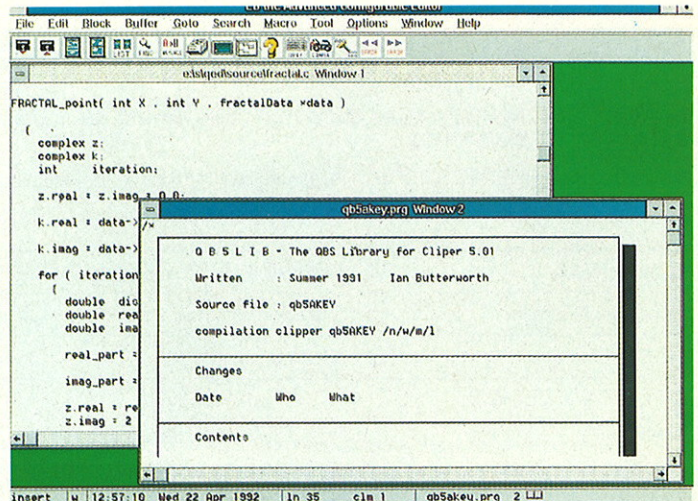
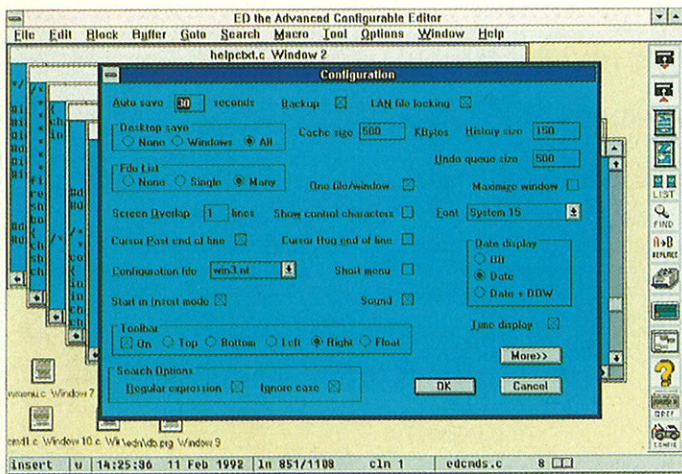
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tion returns 1 if there is a selection and 0 otherwise, or use EditGetText to return the text of the current selection.

The review started in error (the product is called 'ix' not 'Ix' and ended likewise (it is priced at £95 not £99.95) and gives every indication of having been written without reference to the manual and with only the briefest exposure of the product.

Andrew Horton

Positive Ltd

The ix/Ix business is an editing fault, not Jules May's. My apologies for this. Here is Mr May's reply to Mr Franks' and Mr Horton's comments:

'I can understand that ED has many satisfied users, and also that PC Magazine liked it. But I didn't. I expected to like it. I wanted to like it. I even tried to like it, but after several weeks of use, like it I did not. I stopped short of apologising for not liking it.'

'Tried very hard to be fair to ED's good points. Even if I do not like it, .EXE readers should be able to make their own assessment from what I have written, and decide for themselves.'

'Having said that, I deeply resent Mr Frank's implication that anyone who doesn't like ED is unfit to pass an opinion. I know you need to have a pride in your accomplishments, but really!

'ix is a different case. Mr Horton accuses me of factual errors. For his information, the

folders did not appear on the menu, neither where the manuals said they should, nor where he now claims they did. I still have the original disk and have checked. The smart-indenting is brain-damaged; it takes no account of whitespace or comments, and it won't outdent.

'ix calls compiling "making" and macro compiling "compiling". Perhaps this is the reason for Mr Horton's considerable confusion - during my testing, he confirmed to me the problem with compiling (excuse me, making) on the phone - it was one of the many occasions when he promised me an update to fix it.

'Mr Horton is right about ctrl-home. The function is called EditLineStart. You can discover that the ctrl-home key is assigned to this, but not vice versa. He's also right about EditIsSel. I searched for something like this - now it has been pointed out, I found it between EditSaveAsStr(FileName) and EditSetSearchStr(String). Thanks for nothing.

'As to the business of editor functions: I went through the function directory in the manual, counting the functions which were either in the menu or attached to a key (77), those which were not (1), and those which couldn't be (14). I think these figures speak for them-

selves - most functions take no parameters and yield no results, and all but one of these is a keystroke or a menu command. (The one, incidentally, is EditMJSplitLine).

'After seeing your program, Positive, I think that it's more than a bit rich for you to accuse anyone of carelessness. Your program is half-finished, it has been like that for the last year, and I don't think you care.'

Windows Editor #3

Sir,

Well, Mr May, I'm sorry you don't like ED for Windows - I and many others do. If any of .EXE's readers would like to find out for themselves, call us on 081 9944842 for a free working demo.

Ian Butterworth

QBS Software

That's quite enough ED - Ed.

Letter of the Month

The writer of the best letter of the month, as judged by the Editor, will receive a £20 book voucher, courtesy of Just Computer Books. The best letter is the one printed first. Please note that letters submitted to this page may be edited.

Desktop FORTRAN

EXPERTS AGREE WHAT TO BUY - THEY JUST CAN'T AGREE WHY!

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Tony Fitzpatrick, Exploration Consultants Ltd.

"I find the FTN77/386 compiler to be fast and easy to use . . . We often download programs under development from a mainframe to the PC to run through this computer."

Rob McLaren
FTN77/386 User.

"Without the FTN77/386 compiler it would have been totally impractical for us to convert our million-line + power system analysis program (PSS/E) to run on a 386 PC."

Wayne B'Rells
Power Technologies Inc.

"FTN77/386 provides more intrinsic functions than any other: functions to manipulate strings, handle screen and keyboard I/O, read the date and time, parse the command line . . . Advanced file manipulation functions allow an FTN77/386 program to work with files in a C-like manner."

Scott Ladd,
Computer Language, Nov. 1988.

" . . . I am very impressed and have decided to shift all our production programs over to FTN77 . . ."

Dr. G. R. Chaplain
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H. Gordon Jensen
FTN77/386 User.

"By far the fastest and most complete FORTRAN compiler that I have ever seen or used in the DOS environment"

Tim Wool
FTN77/386 User.

"The debugger was very easy to use. There is an on-line help facility which made reference to the manual unnecessary."

Mike Gunn and Arul Britto,
EXE Magazine, May 1989.

"For sheer speed and sleekness the (Salford) compiler stands out like a Ferrari among Yugos"

Jack W. Crenshaw, Computer Language, May 1990

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Big Brother

'Warning: you are entering a no-fun zone.' When the Editor decided .EXE should do a comparative review of version control systems, Cliff Saran was last to the door...

Here's a grim scenario. Imagine you are the project manager for a large software project consisting of a team of eight or so programmers. What would happen if source code created by one programmer was overwritten by another? Without some way of preventing a source file from being edited by more than one individual at the same time, this could easily occur. This is where a version control system comes into play - enabling several programmers to work, in parallel, on different components of a software project.

As an added bonus it also logs modifications made to source files, providing a means of tracking-down where and when a given bug was introduced.

Indeed, with the comprehensive report generators of modern version control systems, detailing not only **who** made a given change, but also the number of source code lines that were altered and how long it took, the less scrupulous project managers can easily check-up on who's been putting in the hours.

Hence the (slightly OTT) reference to Orwell's '1984' in the title of this article.

The Ins and Outs

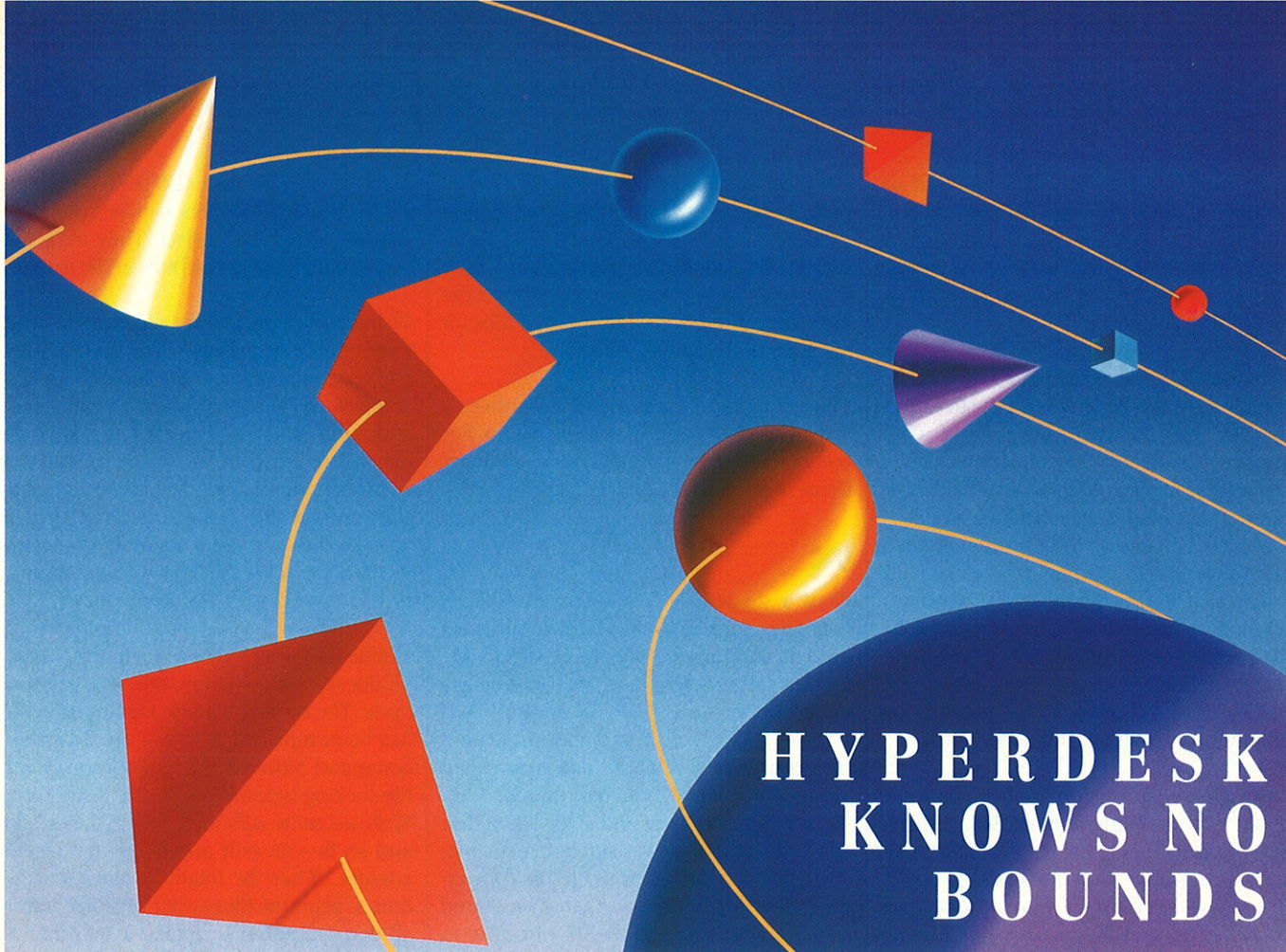
All VC tools operate in more-or-less the same way, possibly having inherited their basic features from the standard UNIX utility SCCS (Source Code Control System). A new source file must first be 'put' into the VC system: the file is archived and is stored as a 'revision' (actually revision 1.0). When a programmer wishes to modify the file he 'retrieves' it; makes appropriate changes; and puts it back when he has finished. This time the VC system will check if there are any differences between the revision stored in the archive (revision 1.0) and the current file being submitted by Put. If there are, the VC system will only store the differences (as Revision 1.1). Also the programmer is prompted to give a brief description of the changes he has made. And so the Retrieve-Edit-Put cycle will continue under version control. Each iteration of this cycle results in the revision number being incremented.

During the development process there may be times when a development path must be split - for instance to incorporate platform-specific features into a project. This is where a branch is used. Branching enables a new line of development to continue in parallel with the original development line.

VC comes into its own when a team of programmers is working on a project. Multi-user VC systems use file locking - analogous to record-locking on a database - to ensure that only one user can edit a source file at any one time. Other programmers on the team are given Read-Only access to the file until it is Put back. This implies that there are two flavours of Retrieve - one provides Read-Write access to the file; the other, Read-Only access. When a file is retrieved with Read-Write access, a flag is raised in the VC system preventing anyone else from retrieving that file with Read-Write access.

	9K	SMS	PVCS
Type of VCS	Single-user only	Multi-user	Multi-user
Platforms Supported	DOS	DOS, OS/2, UNIX	DOS, OS/2, UNIX
Front-End	Text-based Keyboard-only	Text-based Mouse-driven	Windows-hosted -
Editor Support	Built-in File-viewer	Invokes user supplied editor from front-end	PWB PVCS Prof Edit + others
Command-line	Y Slow	Y Extra care with new files	Y Needs VCS.CFG config file
VCS Directives	N	11	8
Help System	Context sensitive	Context sensitive	N
Report Generator	Interactive Fixed-format	Batch-mode User-supplied	Batch-mode User-supplied Audit-trail
Configuration Management	N	Build and Autobuild	Available separately
Special Features	Built-in support for xBASE .DBF	Modification Request facility	Promotion Model project lifecycle
Manufacturer	Forté Software 0989 767656	IntaSoft 0392 217670	InterSolv 0727 812812
Single User	£149	£490	£400
10 User Licence	-	£1764	£3600

Figure 1 - Comparison of version control systems



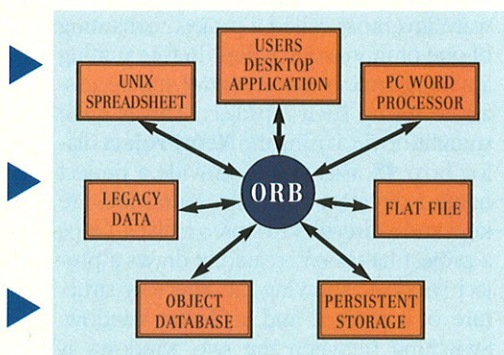
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Multi-user systems run off a network so security is also an issue. To prevent unauthorised access, the VC system keeps a log of which users can see which source files and whether they have Read-Write or Read-Only access.

VC systems come with a suite of tools to complement the basic version control functionality. An essential component of a VC system is the Report Generator, which gives a complete history of all changes made to a given source file, the reason for the modifications and who made the changes. Another utility common to all VC systems is the DIFF tool, which lists the differences between two revisions of a source file. This is most useful for tracking down where a bug was introduced or for showing a programmer the modifications he made to the most recent revision when putting back a file.

Associated with version control is a technique called Configuration Management. This is a grand name for a tool which essentially works like a glorified MAKE utility. Just one version of a software product may consist of several files, each with differing revision numbers. Configuration management tools are able to retrieve all relevant files from the VC system and compile/link them to produce an application. The power of these tools lies in the fact that an application can be built from *any* revision of the source files - ie they are not dependent on the *current* revision of each file.

The Issues

The problem with VC software is not with the difficulty in using the tool - after all most users are happy to make do with only two commands (ie the put/retrieve pair), but with the organisation of a project and its associated source files. In a single user system, the question is that of the directory structure. Where should the source files be placed? Should separate functional blocks be kept in different directories? Should object files be stored separately to source code? Such questions relate to the size of a project - if it is large, a more structured directory tree is preferred. However complicated directory trees tend to hamper navigation in a small project.

More important are the questions concerned with actual working practices, such as when and how often should workfiles be put into the VC system? In a team consisting of several programmers, this is the responsibility of the project leader. Along with the task of dividing the project amongst his programmers, the project leader will additionally have to consider issues relating to security and maintaining the integrity of the software. For instance,

a typical scenario may consist of several programmers, each working in parallel on a different software component of an application. The question is integration - how does one decide whether to retrieve the most recent revision of the source files, or opt for a more 'stable' revision?

The remainder of this article comprises a review of three version control systems. For comparison, I have compiled a summary list of their main features in Figure 1.

9K

9K is a single-user VC system from Forté Software Tools for DOS which provides in-built support for the .DBF xBASE file format. Forté Software is also planning a multi-user version of 9K. 9K is distributed on one 720 KB disk and the installation program creates a single directory called 9K, in which it places all the program files. 9K requires a whisper under 300 KB of disk space. In addition to a single executable, Forté has also provided a .PIF file for running 9K under Windows. All that's required to get going is to add the 9K directory to your PATH and key in '9K'.

9K is based around a user-friendly text-based front-end with drop-down menus. Unlike many VC systems, which work with individual source files, it maintains a software inventory called a project, consisting of one or more source files. Before putting anything under version control, it is necessary to set up such a project. This is quite straightforward using the **New Project** dialog box. 9K asks you to provide a project name, a directory where the source files are kept and a directory to store archives. Once a project has been created, it draws a project window, showing the directory structure of a project, and a file list window. Switching between the two windows is achieved with <TAB>, the cursor keys are

used to navigate, and <ENTER> highlights a file. Highlighted files can be added or removed from the project. They may also be examined using the built-in file viewer.

Changes to a project are recorded in what Forté calls **snapshots**. Like their photographic counterparts, these snapshots give a complete 'picture' of a project at a given time and date. When a snapshot is taken, 9K figures out whether any of the project files have been altered since the most recent snapshot and, if this is the case, the user is prompted to provide a snapshot comment. 9K also provides the ability to associate a given snapshot with a version number.

Unlike the other VC systems in this article, 9K doesn't use the familiar retrieve-edit-put cycle. The retrieve stage is missing, and put has been replaced with a 'Take Snapshot' command. Since 9K is a single-user system, file-locking is pointless. The user has Read-Write access to *all* source files in the project and so he can edit any file to his heart's content. When he finally decides that it's time to place the files under version control, all that's required is to take a snapshot of the project. 9K does the rest. Forté Software has suggested that the easiest way to run 9K is from a DOS shell within your favourite editor. Snapshots should be taken at the end of each working day, comparable to the way we're supposed to back-up our hard disks *every* day, allowing the user to backtrack to any stage in the project.

The Report generator is quite rigid since there is no way to customise the format of information it provides. However, like the rest of the package, it is interactive and has a number of built-in report types. These enable the user to check the history of snapshots/version numbers, look at the state of the project for a specified snapshot/version or compare two files from different snapshots/versions. The file comparison feature is particularly good,

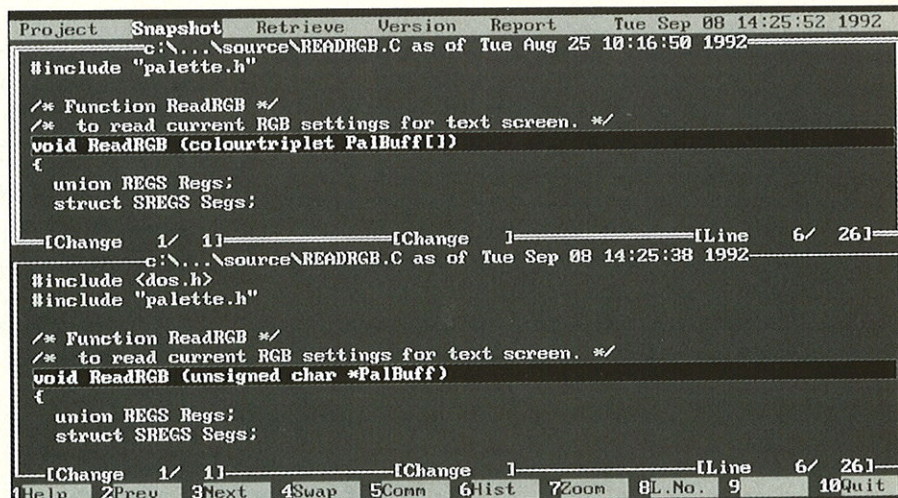
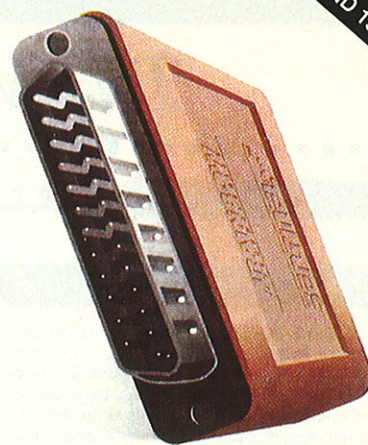
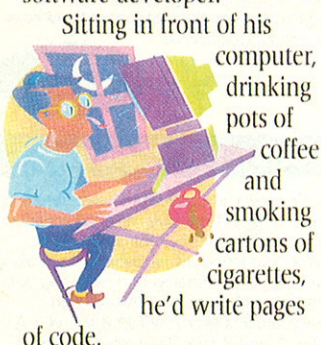


Figure 2 - Split-screen file comparison tool in 9K

Why do they call it a dongle?



He wasn't famous. He didn't drive a fancy car, but dressed in his favorite Comdex T-shirt and faded blue jeans, he set out to change the course of the computer software industry. Quite a task for a lonely software developer.



Sitting in front of his computer, drinking pots of coffee and smoking cartons of cigarettes, he'd write pages of code.

The Most Powerful Program in the World

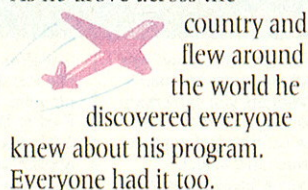
It took time. Years in fact. But he did it. He wrote the most powerful computer program in the world. Now came the hard part. Selling it.

Determined to make those long years pay off, he called on every distributor, VAR and dealer in the world. He drove from Beantown to San Diego. Flew from Dublin to Borneo. Everyone loved the program.

So he sold a few. Only a few.

Back in Boston he waited. After a long year

with only 13 orders he set out to see what happened. As he drove across the



country and flew around the world he discovered everyone knew about his program. Everyone had it too.

The Global Marketplace

From Paris to Prague, his program was everywhere in Europe. When he got off the plane in Hong Kong he found his program stacked to the ceiling in every computer store. Amazed in disbelief, he bought a hundred cartons of cigarettes and a hundred pounds of Indonesian coffee and flew back to Boston.

Beaten, battered and bruised he went back to the drawing board. This time he would really change the face of the software industry. He would develop a device that would prevent unauthorized distribution of software programs.

Call It What You Like

He developed a hardware key. His peers applauded his efforts. Finally, a solid solution for revenue protection.

But he didn't know what to call it. He thought of naming it after an exotic place he visited in his travels. Madagascar was a bit too long, though.

"Name it after you, Don!", urged his peers. So he did. Soon everyone was calling the key a dongle, after Don Gall — the lonely software developer who did what he had to do.

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Today, dongles are different. Fact is, they've come a long way. Leading the industry with security solutions, Rainbow Technologies has changed the face of hardware keys. They work with multiple applications, are programmable and network versions control concurrent usage. And they're always transparent to the end-user.

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install a hardware key into your application in just minutes. Try it with our low cost Sentinel Evaluation Kit. Order one for your DOS, OS/2, Windows, Macintosh or UNIX based application.

And remember, when you need a dongle, you need Sentinel — the only dongle Don Gall would use.

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Agility/VB

Agility/VB is a database engine designed for Visual Basic. Agility/VB's set-oriented function calls make it fast and easy to develop simple-to-use interfaces with a minimum amount of effort. Built-in query-by-examples (QBE) searching facilities make ad-hoc user queries a snap. The View Editor enables the programmer to use a graphical tool to define complex file relationships and indexing criteria for dBASE databases, indexes and memo fields are fully supported as well as a native file format which supports variable length records and fields.

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The Microsoft Visual Basic Professional Toolkit is a collection of add-on tools that extends the capabilities of Visual Basic. Most of the tools are custom controls that can be installed on the Visual Basic Toolbar, so operating as if they were part of Visual Basic itself. These additional controls help you quickly create full-featured applications that include charting, 3-D interface components, MDI child windows, grids, object linking and embedding, pen computing support, animated buttons and more.

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PDQComm for Windows is a comprehensive library of subroutines and functions for adding communications to programs written in Visual Basic for Windows. It contains both high and low level routines for controlling the communications ports, sending and receiving data (XModem, YModem, XModem-1K & ASCII) and popular terminal protocols (ANSI, VT52 & VT100). All of the Assembler, C and Visual Basic source code is included. PDQComm for Windows comes with a comprehensive owner's manual, demo programs including a terminal program.

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MicroHelp VBTools

VBTools customises Visual Basic for Windows' Toolbox to create a programming environment tailored to the needs of the programmer. More than 30 custom controls install themselves in the Toolbox and you program them just like regular controls. Includes: sizzling graphics special effects that transform one bitmap to another; 'how to' info on using popular Windows API calls, 3-D effects and routines to do mouse scrollbars.

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Q+E Database/VB is a complete set of database custom controls that let you quickly create database applications without writing code. For example, scroll bars that automatically scroll through your database records are just a point and click away. With full record locking so you can put your finished applications on the network - royalty free. Q+E/VB has all the functions you'll ever need and it's full dBASE compatible. You can even store pictures and bitmap filenames directly in the Q+E/VB database.

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£49

Visual Basic Shareware

The Visual Basic Utility Library by EMS is probably the best £40 you could ever spend. A collection of over 170 files specifically for Visual Basic for Windows, this new library contains a wide variety of applications and utilities, most with source code. It also includes a Windows based directory of all files in this library and many commercial Visual Basic utilities and add-ons including, communications, business, desktop, disk, finance, language extensions, programming utilities, printer utilities and many more.

£40

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using a multicoloured split screen to highlight differences between two source files (see Figure 2).

As I stated earlier, a nice feature of 9K is its ability to store xBASE files. Whenever a .DBF file is added to the project, 9K gives the user the choice of either storing just the structure of the table or saving the data as well. When the table and its data are put under version control, 9K tracks changes made to both the database structure and database records - adding a transaction log-like facility to dBASE. However it doesn't keep track of index files - but these aren't relevant to VC since they only affect the speed in which data can be accessed.

Documentation takes the form of an 88 page spiral-bound *User's Guide* with examples to illustrate how to use 9K. Forté Software also includes a context-sensitive Help system with the package.

I'll end with brief mention of the command-line version of 9K: it does exist, but it suffers from complicated command-line flags and simply invokes the front-end to perform the required operation. I would guess that most users would stick with the front-end - since it can be run from within a text editor.

SMS

Software Management System (SMS) from Intasoft is a multi-user VC system available for several platforms including DOS, OS/2 and UNIX. The review software was a single-user licence of SMS for MS-DOS. The rather primitive installation from three 720 KB diskettes uses a batch file to copy the executables onto the hard disk. This must be modified in order to change destination drives or directories. SMS consists of 43 files and needs just over 1.5 MB of disk space.

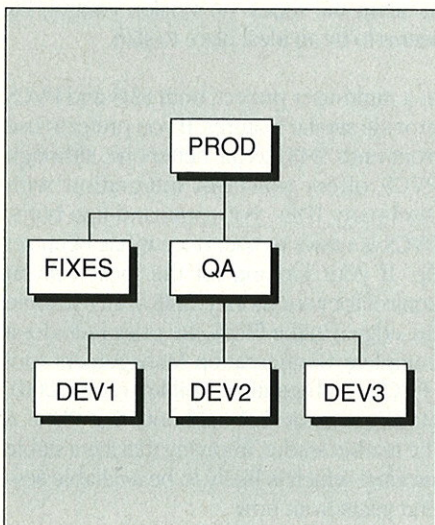


Figure 3 - Lifecycle of SMS's Modification Request

Like 9K, SMS offers a text-based front-end which encapsulates the complete VC system. However the SMS front-end is not as 'pretty' as 9K's and it lacks drop-down menus. The user is subjected to numbered menu items, although these can be selected with a mouse. In SMS, a project is synonymous with a directory. Unlike 9K, I could find no particular significance of an SMS project (ie for grouping all project files together), apart from the fact that the project directory *always* contained a subdirectory called SMS which held the archives.

One of the problems I encountered with the system is that certain important functions, such as selecting files from the file list, are not available from the menu and use non-standard keys. For instance to display the file list you have to press the <F2> key (<F6> gives you the archives list). Intasoft explained that the interface was designed this way to be consistent across all platforms that SMS could run on (even VAXes).

Unlike 9K, there is no built-in file viewer. However SMS can be configured to call your own editor when the **Edit File** menu item is clicked. Files are retrieved from the archive with the TAKEOUT command and put back using PUTAWAY. As SMS is a true multi-user system, it provides a full file-locking facility. In order to retrieve a given file, it is necessary to select it from the archive file list; putting the file back involves selecting it from the source file list. To simplify this process somewhat, Intasoft has included the facility to TAKEOUT and PUTAWAY files automatically each time the user selects a file to edit. SMS supports several VC directives (such as \$LOG\$) which can be inserted as comments into source files to tell SMS to write certain information to the file every time it is PUTAWAY. This information includes the date,

reason for modification and the name of the user who made the change.

Two types of reporting are provided by SMS. The first is 'smsinfo' which give information about the archive in a fixed format. Output is written to a text-file. The user can specify a particular revision to look at or examine revisions either before or after a given cut-off time or date. The other reporting function is 'smsrep' which provides similar output. However it enables the output to be customised using a configuration file. This lets the user select which information should be included in the report and the order in which the information is presented. For instance, a project manager may wish to produce a complete report of the entire project for himself, and create a summary for his superiors. A file comparison utility is also provided, although, unlike 9K's, it isn't interactive.

Intasoft has included the Autobuild tool to simplify configuration management. This uses a template called BUILD.TPL to create a 'Build' file for compiling/linking an application stored in SMS. Autobuild can't determine dependencies on include files automatically, although it can create the simple object filename : source filename relationship. The Build file itself can be edited to add user-supplied compilers/linkers/librarians etc. When files are added or deleted from the project, Autobuild re-creates the Build file.

Another feature of SMS is the Modification Request (MR) facility. A MR provides a formal way of reporting and fixing bugs. When a MR is created, it is associated with a given source file and is assigned to a specified user. A MR has a life cycle, starting with **submitted** and ending with **released** (See Figure 3). When a user decides to work on

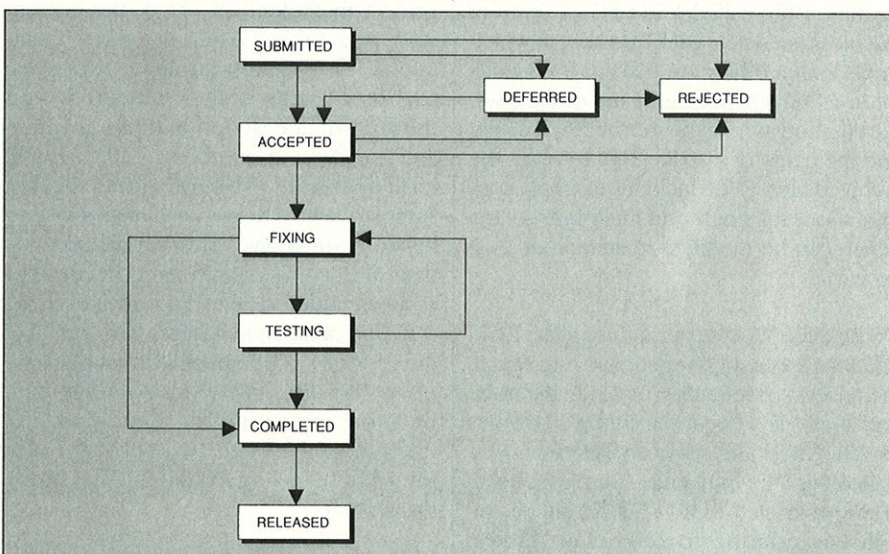


Figure 4 - Promotion Model for a typical PVCS project

the MR, he changes its status and alters the given source file. To keep the MR synchronised with the revision of the source file, it is updated each time the file is retrieved or put back into SMS. The MR is actually stored as a text file, so the truly high-tech project managers among you can send the MR electronically to an unsuspecting member of your programming team.

Documentation in SMS is extremely good. There's a 26 page *Tutorial* and a 220 page *User's Guide*. The User's Guide is arranged alphabetically as a command reference with many examples. The front-end has a built-in context-sensitive Help system which is fairly easy to use.

SMS also comes with a command-line version of the package which is entirely independent of the front-end. One of the problems with using the command-line tools is that the PUTAWAY command must be given a special flag the first time a new file is placed under version control. This could cause problems when creating a batch-file driven VC system with SMS.

PVCS

Probably the most widely used PC version control package to date is Intersolv's PVCS Version Manager (VM). This is a multi-user VC system for DOS, OS/2 and UNIX. The latest release is V5.0. This is distributed on twelve 720 KB diskettes and a full installation consumes about 8 MB of disk space. The review software was PVCS VM V5.0 for MS-DOS (single-user licence). The package includes both Real and Extended mode versions of the software.

Getting started with VM is an order of magnitude more complicated than either 9K or SMS. The first step involves creating a configuration file called VCS.CFG. A copy of this file is needed in each directory in which project source files are placed. It contains information such as the name of the user, the directory where the source files are kept and the name of the directory to place the archived files. PVCS includes example configurations for single and multi-user setups which can be modified to suite your own projects.

Of the three VC systems in this article, PVCS offers the least sophisticated front-end. In fact, the review software didn't include the front-end at all - it is due to be shipped later this month. Under the advice of Intersolv, I installed the V4.0 front-end. Apart from being Windows-hosted, the PVCSWIN front-end really has nothing to offer. On starting PVCSWIN, the user is confronted with a simple dialog box with radio buttons for se-

lecting the following commands: Fetching/Retrieving files from the archive, Report Generating and comparing files. When one of these is selected, the appropriate dialog box pops-up and the user has to type in all the information required (ie file-

The PVCS front end is completely inappropriate, but it does integrate with various IDEs

names). No use is made of the more sophisticated Windows controls such as file list boxes. As it stands PVCSWIN is best avoided.

However this is not the case with the command-line tools. Once VCS.CFG has been set up, all that's required to use PVCS is the PUT and GET pair of commands. Like SMS, it supports full file-locking and a number of VC directives that may be placed in source files.

PVCS provides a number of report-generating tools. The first is the JOURNAL which outputs an audit trail of all PVCS commands that have been used to modify the archive (ie PUT and GET commands). The information is presented with the date and time that the command was invoked, together with the user who performed the operation. The VJOURNAL command is used to view the journal. A project manager can check the current state of a project using the VLOG command. This details archive attributes, such as the name of the user who created the archive, a description of the workfile and the revision numbers of all currently locked revisions. It also provides a revision summary which shows a log of all revisions made to an archive. This log includes the date/time a revision was made, the number of lines added/deleted/moved and a description of the modification. The format of the report can be specified using a template .RPT file. There is also a file comparison program for checking the differences between two revisions of a file without having to take the files out of the archive.

Work on a large software project will tend to consist of several distinct phases (ie De-

velopment, Testing and Quality Assurance). In PVCS, source files can be grouped together and be moved, as a single unit, through these stages in the project lifecycle. When a group is 'promoted' from development to the next level (eg Testing or Quality Assurance), PVCS locks the groups, preventing any project source code from being modified. The only way one can change source code is to use the VPMOTE command to downgrade the project back to Development (see Figure 4). This technique enables the project manager to reduce the risk of introducing bugs into software at a late stage in the lifecycle.

PVCS comes complete with comprehensive documentation. There is an *Installation Guide* and an 85 page User Guide called *Getting Started* which runs through a simple tutorial to demonstrate the main features of PVCS and to examine the principles behind version control. Source code required by the tutorial can be found in the PVCS\VMTUT directory. A 437 page *Reference* manual provides an alphabetical list of all PVCS commands. Finally there's a *Quick Reference* and *PVCS Extensions* which shows how to link PVCS into several IDE's.

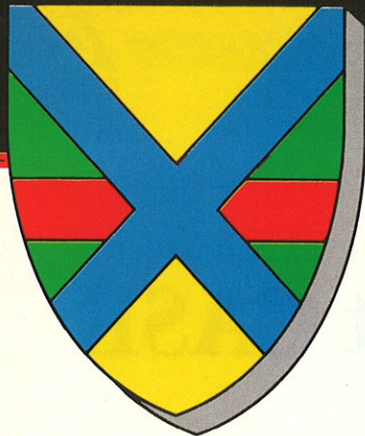
Although the PVCS front-end is completely inappropriate as it stands, PVCS does offer the ability to integrate into the IDEs of IBM AD/Cycle WSP/2, Micro Focus Cobol Workbench, Microsoft PWB and HP Softbench.

Conclusion

Although version control on a single-user project is perhaps a tad over-the-top, 9K seems to offer the best value-for-money in this league. An attractive price, fully integrated front-end and ease-of-use makes it a good buy. Furthermore, for those of you who wish to 'learn the ropes' on version control, 9K seems to be an ideal place to start.

In a multi-user project, both SMS and PVCS provide similar features. If you prefer to use front-ends SMS has the better one, although PVCS offers powerful integration with third-party IDEs. For command-line buffs, PVCS is easier to use, once it has been set up. If your looking for the most version control for your money, SMS seems to have the edge. Unlike PVCS, the price includes a complete Configuration Management tool (PVCS Configuration builder costs £200). However readers should note that PVCS is the market leader, implying that it is a stable product which is likely to be available several years from now.

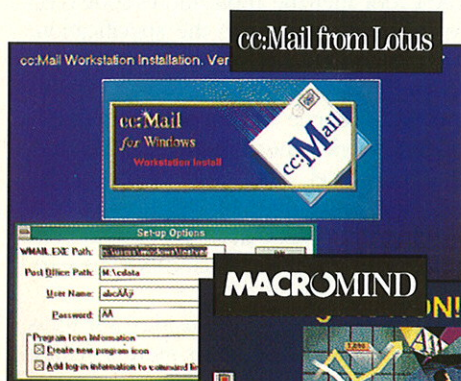
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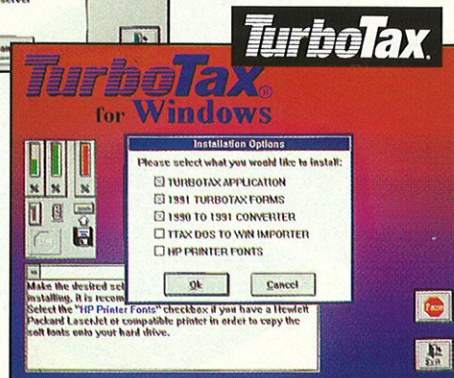
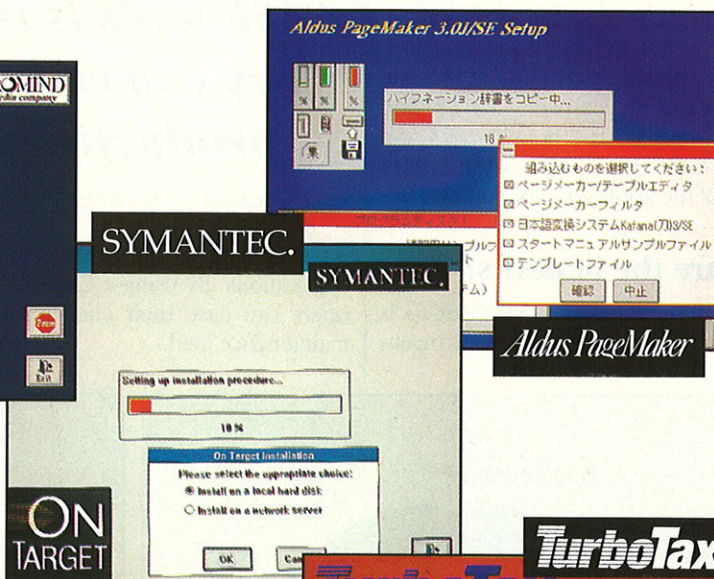
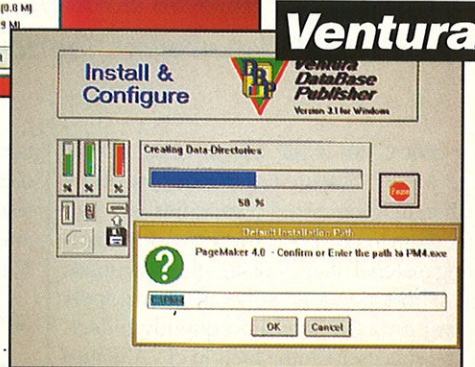
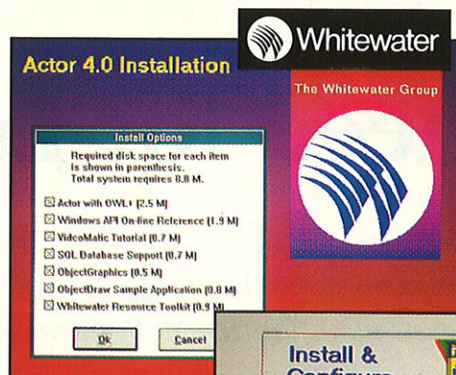
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The need for Low Cost CASE

Received wisdom states that CASE is only worth considering if you operate a huge DP department. Patrick McParland argues that it has wider application.

Low cost CASE is the use of CASE (Computer Aided Software Engineering) tools by small to medium-sized companies on small to medium sized applications. Vendor's marketing material often contains glowing praise which independent software developers shower on a CASE tool, frequently reflecting the successful introduction of CASE into a large multinational corporation. As a consultant, based in Northern Ireland but working throughout the UK, I have often recommended the use of CASE tools. However, when dealing with smaller companies such advice can be impractical due to the cost and verbose nature of many CASE tools.

For CASE to become successful, it must be made palatable to companies developing small applications. The benefits of CASE must outweigh its weaknesses regardless of the scale of the application or company.

What are the benefits?

By far the major benefit in using CASE tools is the reduction of resources required to main-

tain applications which developers build using the CASE tool. Many studies claim that maintenance makes up between 60% and 80% of a project's costs (see Figure 1). Some CASE tools provide reverse engineer-

One of the major weaknesses of the use of many CASE tools is that they can reduce productivity

ing tools to assist the maintenance of old applications. By using a CASE tool, developers can ease their current and future maintenance load.

CASE tools which provide automatic code generation facilities, aid maintenance by keeping a dynamic relationship between the application's specification and its code. If a developer changes the specification and regenerates the application using the CASE tool, then the application's code is up to date with respect to the specification. Maintaining an application is easier when its specification is available. CASE tools also aid maintenance by encouraging developers to work at the design level rather than the code level. They also provide cross reference and impact analysis tools (which highlight the objects in an application's development which are affected by a change).

The other major benefit of using CASE tools is their support for one or more software development methods (eg Information Engineering or SSADM). In fact, to use a CASE tool without a method is equivalent to driving a car without previously having taken driving lessons or referring to the highway code. By supporting such a method, a CASE tool encourages software developers to de-

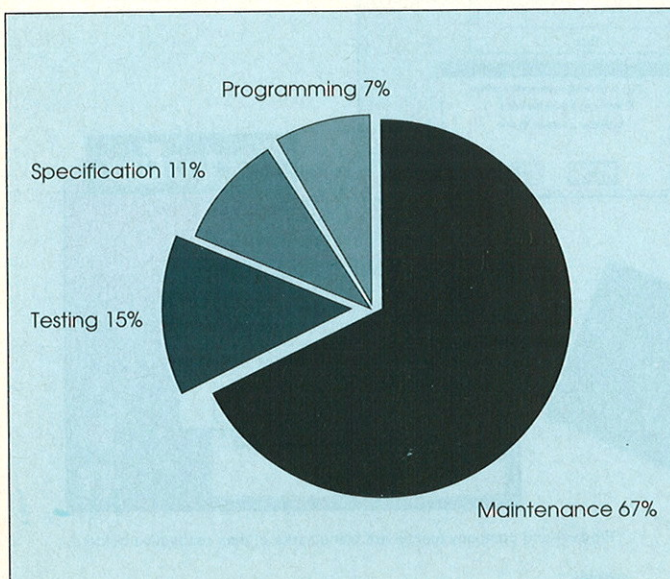


Figure 1 - Total Project Costs

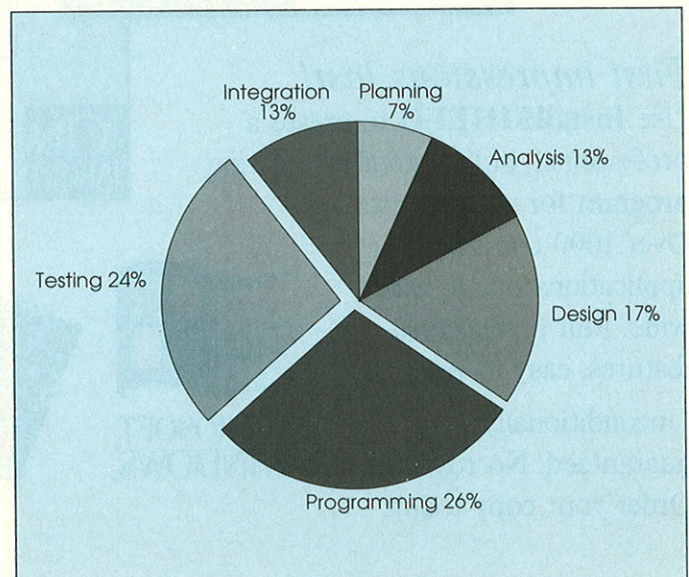
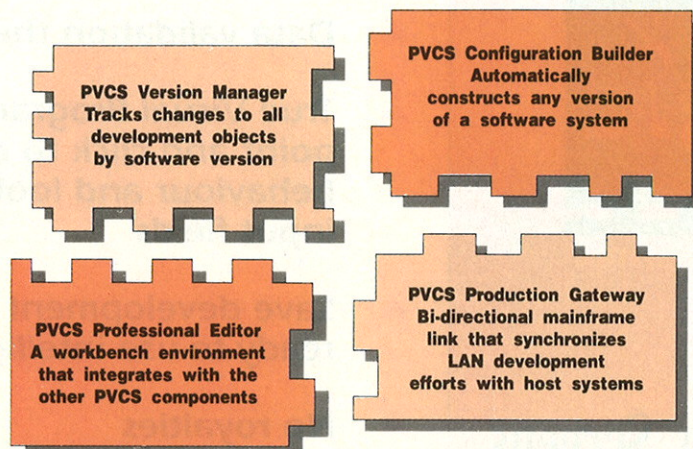


Figure 2 - Development Effort by Software Life Cycle Phase

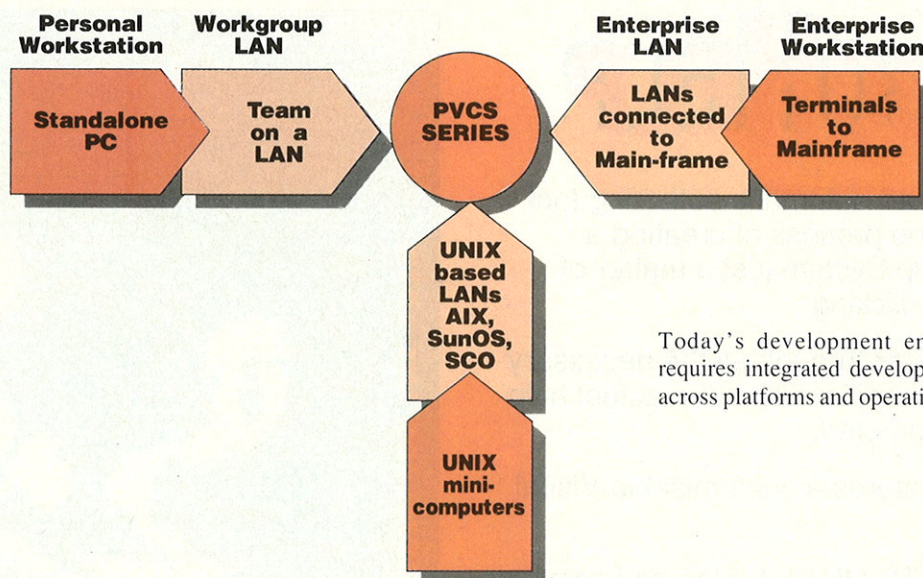
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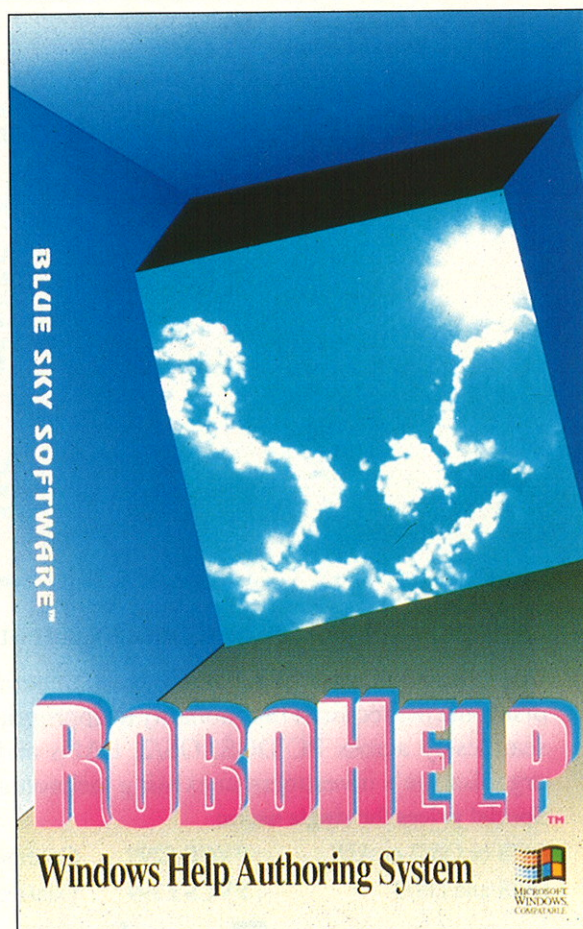
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velop their applications in a more structured way. If all developers apply the same method, then new developers can be incorporated into a project team more easily. Also controlling and managing the development of large applications is simpler because all developers are using the same development techniques and notation.

A further benefit of using a CASE tool is its support for new technologies. The CASE user relies on the CASE vendor to provide support for the development of applications which use the latest GUIs (Graphical User Interfaces) or client/server architecture. The technological risk of choosing which window manager or client/server architecture to support is shared equally by all companies using a particular CASE tool and its vendor. In general, most CASE tools will seek to support the most widely used window managers and client/server architectures. They do so in such a way that developers will not have to take account of which window manager or client/server architecture they wish to use until they want to generate their application. The CASE tool's code generator can then be configured accordingly. Porting applications between different code generator configurations is not usually a major problem.

CASE weaknesses

Despite the vendor hype to the contrary, one of the major weaknesses in using of many CASE tools is that they can reduce productivity. This is particularly true during early usage of a CASE tool. Developers can take many months to become familiar with the development method the CASE tool supports and the CASE tool's facilities. However, even after the developer overcomes this learning curve, productivity may not

differ substantially from what it was prior to the introduction of the CASE tool. This is because a CASE tool encourages developers to spend more time analysing and designing an application and less time on programming. However, as Figure 2

Despite their disadvantages, the application of low cost CASE tools can be a useful addition to a company's tool portfolio

demonstrates, programming takes on average 26% of resources in a typical development environment. Savings in the programming phase of the software life cycle, although important, may be offset by extra effort during analysis and design (which take 30% of resources).

However, perhaps the most serious problem with many current CASE tools is their cost. Prices range from £3,000, for a single PC copy, to over £300,000, for a multi-user licence on a large mainframe site. Further costs are also necessary for training and possibly consultancy. Some authors claim that for every £1 spent on the acquisition of a CASE tool a further £2 is necessary for

training and consultancy. Certainly, if you buy a CASE tool then you should budget for a large amount of training.

Justifying this expense to a prudent financial director can be a major problem. This problem is compounded when you consider that the company will probably not receive a return on its investment during the current financial year. In particular, savings on the development of a new application, using a CASE tool will only be realised when the application is being maintained; long after its initial development is complete.

A further weakness of some CASE tools is that the methods they support are too verbose. The development of even the simplest application becomes a major task. This is particularly annoying when a developer could build the same application quicker, while still keeping the application maintainable, using a 4GL. Thus for small or even medium sized applications the use of a CASE tool, with all its analysis and design techniques, can be a huge overkill.

CASE for small companies

The above weaknesses with CASE tools virtually kill off the possibility of a small company (or a small DP department) adopting a CASE tool as its main development tool (especially in the current economic climate). Even a medium sized company may not be able to afford the expense. Also, if the major advantage of CASE tools is in easier maintenance, then small to medium sized companies with fewer, and perhaps smaller, applications to maintain may not have major maintenance problems which require a CASE tool as part of the solution.

Product	Areas Supported	UK Distributor	Approx Price per Single User Copy
CASE:W CASE:PM	Design, Prototyping, Code Generation	QA Training Ltd, Gloucs. GL7 2EF	£995-£1795 - PC
Easy CASE	Analysis, Design	Software Construction Company, Royston SG8 5DB	£320-£420 - PC
POSE	Analysis, Design, Code Generation, Reverse Engineering	Savant Enterprises, Camsorth LA5 9BX	10 modules @ £510 each - PC
Prototyper	Analysis, Design, Code Generation	Softline Distribution, Sutton SM1 RJH	£195 - Mac
Select/SSADM (also a HOOD version)	Analysis, Design	Select Software Tools, Cheltenham GL53 9QS	£495 - PC
Smart CASE	Analysis, Design	Software Construction Company, Royston SG8 5DD	£195 - PC
System Developer I	Analysis, Design, Code Generation	Software Construction Company, Royston SG8 5DD	£325 - PC
System Architect	Analysis, Design, Code Generation	Real Time Methods Warwickshire W32 4QY	£1,145 - PC

Figure 3 - Example Low cost CASE tools

However, all companies, regardless of size, should adopt a software development method. The use of a common method throughout a company enforces rigorous development techniques, a common notation and documentation standards. CASE tools are the best means of imposing such a method on an organisation. Thus there is a market for low cost CASE tools.

Low cost CASE is a CASE tool which is reasonably priced and does not enforce a verbose software development method. It often consists of a set of analysis and design tools supporting a wide variety of techniques and notations. Rather than supporting one development method in detail, developers are able to combine the techniques and notation in a form which is suitable for the type of application they are building. For large applications, developers can apply a full software development method akin to Information Engineering and SSADM. For small projects the combination of Entity Relationship Diagrams and Data Flow Diagrams may be enough. Example products are shown in Figure 3.

Some products, like POSE, consist of a large set of modules. Initially developers acquire a small subset of modules and acquire more if they require further CASE tool facilities.

Note that the prices above are approximate and that multi-user copies are available for some of the products.

Low Cost CASE

The above products do not have the same functionality as a large I-CASE tool such as IEF, IEW or Foundation. In fact, many



only support analysis and design with limited automatic code generation facilities. However, the general strategy of these products is to satisfy the 80/20 rule, ie provide 80% of the functionality of a major CASE tool at 20% of the cost.

The most obvious advantage of these low cost CASE tools, over I-CASE tools, is their relative cheapness. This means that their

If CASE is to become more successful, it must be made palatable to companies developing small applications

acquisition is less of a risk for a company. Therefore if the CASE tool is not giving the desired results then the company's profits will not suffer. Nor will the demise of the CASE tool be a major crisis, so the DP department will not try to save it by (for example) spending more money on consultancy.

A further advantage of these low cost CASE products is that a company of any size can use them to 'try out' CASE before making a major investment. Introducing a CASE tool requires a major culture change in an organisation so a pilot study, using low cost CASE tools, may result in the company learning some valuable lessons. If the initial results with a low cost CASE tool are positive the company could consider the more expensive I-CASE (Integrated CASE) products before making a final decision on which CASE tool to use.

The main disadvantage of acquiring such low cost CASE tools is their lack of integration facilities compared with the major CASE tools. Many low cost CASE tools cannot be integrated with other software tools such as project management tools and version and configuration control tools. They may also have limited code generation facilities so developers may have to resort to hand coding after the analysis and design phase of an application's development. Thus the direct rela-

tionship between the specification and the code, which many I-CASE tools preserve, is severed. Therefore developers will be responsible for ensuring that changes to the code are reflected in the design and *vice versa*.

Despite the above disadvantages, the application of low cost CASE tools can be a useful addition to a company's software tool portfolio. However, the acquisition of software tools, whether low cost CASE or I-CASE, should be within the confines of a company's software development strategy. Such a strategy outlines the approach to software development within a company, regardless of size. It defines the techniques and tools developers should use and the procedures for managing a project including the use of project management tools, if appropriate. Ensuring that a software development strategy is integrated (ie software tools can at least share or interchange data) and complementary is a key way of reducing redundancy within an organisation and maintaining control.

When considering the acquisition of a low cost CASE tool, buyers should look beyond the price tag and the plethora of techniques it supports and consider how the product could be used to support their company's software development strategy. Also, despite the relative cheapness of low cost CASE tools, a company must still be convinced of the business need for using a software tool before its acquisition.

As with all products, 'you pay your money and you take your chances'. Using a low cost CASE tool, small companies can attain many of the benefits of CASE without risking the company's survival. Also, large companies can experiment with CASE tools without requiring approval from the board room for a major investment in a new technology.

EXE

Patrick McParland is a consultant with the Institute of Software Engineering. He specialises in the introduction of CASE tools in companies of all sizes and recently completed a report on the use of CASE tools. For further information on any of the points made in this article contact the Institute of Software Engineering (0232 738507).

Thanks are due to Miss Margaret Largey, of the Institute of Software Engineering Information Service, for her assistance in preparing this article.



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Award Yourself VC

Malindi Lamb sings the praises of Version Control and Configuration Management.

The terms 'Version Control' and 'Configuration Management' have been around in the IT industry for some time. In the worlds of academia and corporate DP departments they are known and respected; but commercial software houses and application developers have only recently begun to discover them.

This has been due to users not understanding the benefits and, more practically, to a lack of suitable automated tools. The increasing demand for improved software quality, highlighted by the recent report by the Pyramid consortium entitled *Quantitative Management: Get a Grip on Software!*, is leading to a demand for information on methods of quantifying software quality. Both developers and users want to be able to benefit from the techniques without being buried in bureaucracy. Version Control and Configuration Management can provide a practical option.

During the life time of a project, hundreds of 'Configuration Items' (CIs) may be generated: requirements specifications, design diagrams and documents, software modules, derived objects, documentation, change requests etc. These CIs will all change many times for a variety of reasons - perhaps variants for different customers or hardware platforms, changes in the requirements or bug fixes. Add to that the fact that there may be a number of designers and programmers implementing those changes and it is easy to see how quickly you can create a nightmare for the person who is trying to manage the changes and configurations of the product.

Version Control is at the heart of Configuration Management. By recording and maintaining a complete history of each CI, it can answer the questions Who? What? When? and Why? - Who made the change? What change was made? When was it made? and Why was it made?

Configuration Management is broader, and covers management of all the configurations of the CIs that make up a product, the process

of change, configuration building and release management.

Version Control and Configuration Management are relevant to all stages of the software life cycle, but are particularly pertinent to the maintenance phase. This is traditionally re-

Version Control is at the heart of Configuration Management

garded as coming at the end of the life cycle, but in reality occurs at each stage. Maintenance is the most costly part of the software development process - estimates vary from 50% to 80% of the cost of a software project.

By using Configuration Management techniques, it is possible to maintain a complete history of the versions of every CI in the software development process, together with information as to the date/time of any change, the author of the change, the reason for the change and what the change involved. A detailed record is also kept of the constituents of any particular release, together with the versions of every constituent that makes up a release, whether the release is for production purposes, for test or any intermediate level where a stable state is required to be recorded. Furthermore, it should provide access to any previous version at any time.

Even the smallest single-user project can benefit from the simplest type of Version Control, to maintain a version history. For larger projects, the benefits of managing the development undertaken by different programmers to ensure that they do not overwrite each others' changes, become even more obvious.

However, manual implementation of such techniques can be extremely time consuming and, as a result, it can meet resistance from development staff. Since there is no point in instituting procedures which are going to be ignored or circumvented wherever possible, it is apparent that Configuration Management Tools are necessary if Configuration Management is to become accepted generally. Such tools improve productivity by ensuring work done is not lost, assist in tracking down bugs and automate tedious manual tasks.

They offer a variety of additional functionality including Change Control, which automate change requests. This encompasses all aspects of controlling change to CIs, in terms of access and Modification Requests (MRS). These are controlled by recording and defining the whole life cycle of an MR from receipt, through acceptance to closing, facilitating assignment to programmers, and monitoring of progress at all times.

All good Configuration Management Tools incorporate powerful report generators which produce reports providing users with detailed information on the software development cycle.

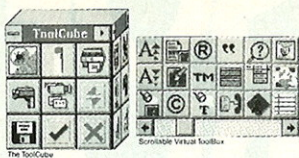
The issues of reuse and OO must necessarily promote the techniques, because it will be impossible to manage a library of objects and reuse them without having a very comprehensive Configuration Management system which can identify *which* versions of *which* objects were used in a particular package. Furthermore, with the increasing interest in BS5750 quality standards, Version Control and Configuration Management will have to be more widely adopted, resulting in more reliable, efficient production of software.

EXE

Malindi Lamb is the Managing Director of Intasoft Limited. Intasoft's SMS package is one of the version control systems reviewed by Cliff Saran elsewhere in this issue.

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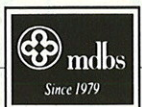
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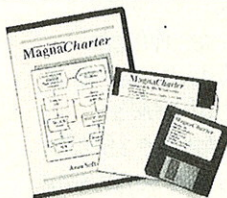
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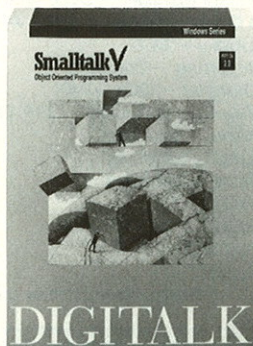
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TIFF Files: How to Read and Write Them

Graeme Webster explains one of the most popular file formats used to store graphics images.

One of the main problems with computer graphics is not so much the absence of standards as the presence of too many! To be sure, attempts are made to introduce standards for the exchange of graphical information, such as GKS (Graphical Kernel System, ANS X3.124-1985) or PHIGS, but the rapid changes in the technology such as the introduction of 24 bit colour, z-buffers for rendering and so on, have made it hard for the standards makers to keep pace with these changes.

There is, of course, a view which says that at a time of rapid technological development the too early imposition of a standard serves only to stifle innovation and is therefore *not a good thing*. On the other hand, the cynic might say that it is in the manufacturers' interests to try to ensure that customers are restricted to proprietary formats so that, once caught, they are compelled to stay with that manufacturer's software.

Types of Image File

There are three basic kinds of graphics file. The extremes are, on the one hand, those in which the data is essentially in the form of lines and curves as typified by CAD data, referred to as *vector files* and those in which the data is a mapping of the pixels which go to make up a raster display of an image and known as *raster files*. Finally, the term *meta file* is used to describe files which contain a combination of the two kinds of data. In practice, applications tend to adopt one or other of the first two file types, vector files for CAD and line drawing, raster files for images, pictorial graphics, electronic painting and the like.

This article is concerned with one of the most popular of the raster file types the 'Tagged Image File Format' universally known as the TIFF format. These files generally have a .TIF DOS file extension.

Work on the definition of the TIFF format, as a non-proprietary standard for the interchange of raster image data, was started in 1986 by the Aldus Corporation. Version 6.0 of the specification came out in 1991. Aldus still administers the core specification, but a number of other big name companies, eg Hewlett-Packard and Microsoft, are also involved in its current development. TIFF provides a general purpose format which is compatible with a wide range of image processing systems. It is, probably, the most widely supported scanned-image file format in use on personal computers. The open ended nature of the tag system used means that the format is fairly future proof, and should be capable of supporting increasingly sophisticated hardware and applications without fundamental alteration. TIFF is not dependant on any particular hardware platform or operating system and is used on IBM PC compatible, Apple Macintosh, UNIX, NeXT and other environments.

TIFF Structure

Although most TIFF files contain only a single image, multiple images are permitted in one file (for example, I use this feature to keep together a full size image and a miniature of it, which can be used in an image browser). To allow for this possibility, the TIFF file consists of a header that occupies the first eight bytes, then one or more subfiles, one for each of the images contained in the TIFF file. Referring to Figure 1, in which the size in bytes of entries is given in square brackets, each subfile contains an *Image File Directory* (IFD), additional offset information and the image data itself. The IFD is a set of 12-byte records (tags). Together these describe the characteristics of the image, how big it is, how the bytes of image data are to be interpreted and so on.

The Header Field

The header is the only part of a TIFF file which is in a fixed location. Figure 2 shows the header fields and their offsets from byte 0 of the file.

The byte order is either the two ASCII characters *II* (49h 49h), signifying Intel byte ordering, or *MM* (4Dh 4Dh), signifying Motorola byte ordering. This distinction is made because, for 16 and 32-bit quantities, Intel processors treat the first byte as the least significant whereas Motorola treats it as the most significant. TIFF writers are allowed to

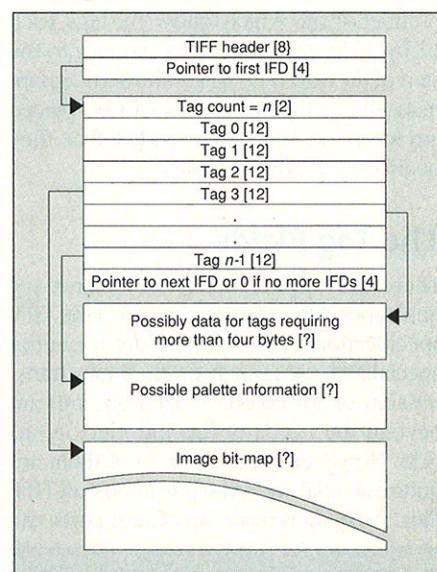


Figure 1 -
General structure of a TIFF File

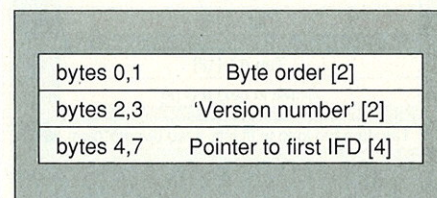


Figure 2 - File Header

adopt which ever scheme is most convenient, telling the world what it has done by putting II or MM in bytes 0 and 1. TIFF readers are not allowed that luxury and must recognise and deal with either case.

The next two bytes of the header are always '42'. This is not a true 'version number' but, as the Specification says, is chosen for *deep philosophical significance* (ie Douglas Adams). The Specification also gives the practical advice that if think you have a TIFF file and these bytes are not '42' then the nature of the file specification will have been so radically changed that you should give up trying to interpret it at that point. Indeed, the combinations of 'II' and '42' or 'MM' and '42' can usually be taken as *prima facie* evidence that you are dealing with the genuine article.

Finally, bytes 4 to 7 are a 32-bit pointer to the location of the first byte of the first IFD. If there are additional subfiles, these are located through a similar 4-byte pointer placed at the end of the previous subfile. The last subfile is marked by a zero pointer. All pointers and offsets in TIFF files are absolute byte counts and refer to the start of the file, thus the first byte of the file has an offset of 0.

The Image File Directory

An IFD has three components appearing in a fixed order: a two byte count giving the number of tags which follow; the tags, each 12 bytes long; and the byte pointer to the start of the next IFD. This is shown diagrammatically in Figure 3. IFDs can be placed anywhere in the file provided that they begin on a 2 byte boundary.

The Tag Fields

There are approximately 60 distinct tag field types defined in version 6.0 of the TIFF specification. Some of these are for rather specialised uses, such as facsimile transmission or for colour separation, and are beyond the needs of this introductory article. However, a dozen or so of them are quite essential and appear in almost all TIFF files. Each tag is made up of four parts: the

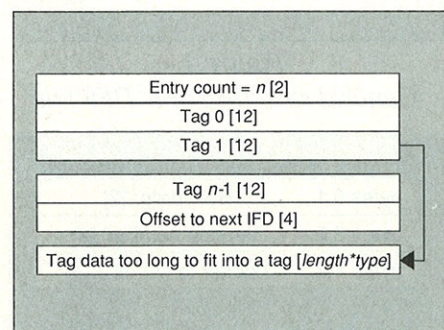


Figure 3 - Image File Directory

Serial number	Type	Length	Data or offset
2 bytes	2 bytes	4 bytes	4 bytes

Figure 4 - Tag Structure

tag serial number, the type of the tag value, the number of values in the tag (usually rather misleadingly referred to as the 'length') and the tag data or an offset. If the tag value is less than four bytes then the value is stored in the tag itself. If the value is too long to go in, the four bytes in the tag are a pointer to the file location where the actual value is to be found. Figure 4 shows the components of a 12 byte tag.

Serial Number field

The Specification requires that tags appear in an IFD in ascending order of tag type number. Public tag serial numbers start at 254 (FEh) and run to 321 (141h) and beyond. Private tag serial numbers, starting at 32768 (8000h) may also be allocated by the TIFF Administrator (and of course you can invent your own private tags, on your own head be it!). The use of private tags is discouraged, however, as they can cause confusion for some readers and should only be used as a last resort to cater for some really peculiar situation.

Type field

Five data types are allowed. These are tabulated in Figure 5. Usually only one data type is associated with any particular kind of tag. However, for certain tags more than one type of data is allowed. For example, those specifying image width and image height can be either LONG (32 bits) or SHORT (16 bits). Preferred practice in this case would be for a TIFF writer to use the SHORT type unless otherwise necessary. A TIFF reader, however, cannot just assume from the tag serial number what type of data it is being offered; it is necessary for it to check the type field and act accordingly.

BYTE entities are 8-bit unsigned integers. ANSI entities are NULL terminated strings of 8-bit bytes that store ANSI codes. The length includes the NULL. In fact the NULL is not strictly necessary, but it makes things a bit easier for C programmers. A further complicating detail is that, if necessary, an ASCII string is padded out beyond the NULL to make the total number of bytes even; however, in this case the extra padding bytes are not included in the length count. RATIONAL type is taken to be the ratio of two LONGs, the first representing the numerator of the fraction, the second the denominator. RATIONALs always re-

quire to be pointed to by an offset pointer in the tag data field.

Length field

This field contains the length of the item pointed to by the tag, counting in units of the data type of the tag. So, if the data type were to be LONG, ie 4 bytes, and there were 16 of these, the Length entry would be 16 but the data pointed to would be 16 x 4 = 64 bytes long.

Data or Offset field

The last four bytes either contain the tag's actual data or, if it is more than four bytes long, a 32-bit pointer to where in the file the actual data can be found. You determine which case you have by whether or not the product of Length and the byte size of the data type is less than or equal to four. If the type is RATIONAL the field always contains a pointer. Frequently the data type is SHORT and the Length one (an example is the image width information). In these cases the two bytes of data are left justified in the field. The other two bytes will not contain any significant data, but if you are a TIFF reader **you can not assume them to be zero** - the writer may have put a secret message there!

As previously noted, some tags are intended for specialist use (such as facsimile transmission and document storage and retrieval) while others are no longer recommended. Others appear in almost every TIFF file. As a TIFF reader is not allowed to assume defaults for any tag information, a TIFF writer must supply all the necessary tags to make unambiguous interpretation of the image possible. The most crucial tags which are likely to be encountered when dealing with images are listed below, with their official titles printed in italics.

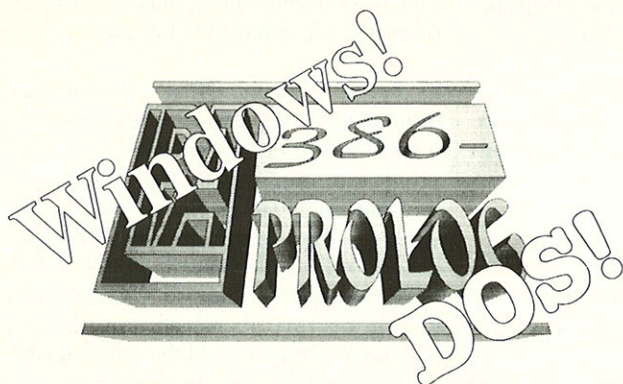
254 New subfile type. A data field value of zero means that the file contains a full size image. This tag is the first one in the IFD.

256 Image Width in pixels. This is the only way a TIFF reader is going to know how big the image is and so is essential

257 Image Length, also essential.

258 Bits Per Sample. A black and white 'Line Art' image will have only one bit per

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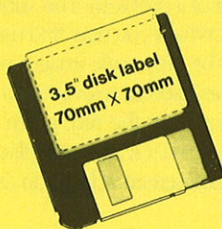


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sample, these being packed eight to the byte. Typical 256 colour palette data will be eight bits per sample.

259 Compression. There are five 'official' compression schemes and several private ones. Compression type 1 is 'no compression'. For colour images the most common schemes are official method 5, a Lempel-Ziv & Welch (LZW) compression using 12-bit codes and method 32773, PackBits compression, originally a private scheme but now in common use.

262 Photometric Interpretation. This tag is required for all images as it tells the reader how to interpret the values in the bit map. Currently five values are defined. The ones most likely to be of interest are 2, RGB data with the minimum sample values representing minimum intensity, and 3, palette colour.

270 Image Description. Title of the image as an ASCII string. Intended for information only.

271 Make. The manufacturer of the scanner, frame grabber or whatever as an ASCII string. Intended for information only.

272 Model. The model number of the scanner, frame grabber or whatever as an ASCII string. Intended for information only.

273 Strip Offset. This is a required tag as it is the only way the TIFF reader has of knowing where the image data starts. The data may be conceptually divided into a number of strips each with its own pointer. This can greatly facilitate data compression if that is being invoked. Of course, if there is more than one strip, the multiple pointers will not go into the tag's data field so the tag contains a pointer to a block of 32-bit pointers to strips. If there are multiple strips, there will also need to be tags 278 and 279.

277 Samples Per Pixel. For monochrome and palette colour this is one, for 24-bit colour it is 3.

278 Rows Per Strip and

279 Strip Byte Count tags.

282 X Resolution. The number of pixels per Resolution unit in the x-, ie image width, direction. This tag is used for sizing images for printing. The data type is RATIONAL.

283 Y Resolution. The number of pixels per Resolution unit in the y-, ie image length, direction. The data type is RATIONAL.

284 Planar Configuration. This tag is required for 24-bit colour. If the tag data value is 1 the image data is in RGB triplets, if the tag data is 2 the image data is given as first the red plane, then the green and finally the blue.

296 Resolution Unit. This tag is used with X Resolution and Y Resolution. Data is of type SHORT. A value 1 means that there are no absolute units; 2, units are inches; 3, units are centimetres.

305 Software. The name and release number of the package which created the image as an ASCII string. Intended for information only.

306 Date Time, as an ASCII string. Intended for information only.

315 Artist. Artist's name as an ASCII string. Intended for information only. If you wish to include a copyright notice in the file a good place to put it is immediately after the eight byte header, adjusting the pointer in bytes four to seven to jump over it.

316 Host Computer, as an ASCII string. Intended for information only.

317 Predictor. This tag is used with LZW compression. Data is of type SHORT. A value 1 means that no prediction scheme is used before coding.

320 Colour Map Offset. This tag must be included in all files of palette colour images. The tag data is a pointer to where the palette information can be found. The palette itself is stored as a set of unsigned 16-bit red values, followed by a set of green values and finally a set of blue values. Black is 0,0,0 and white 65535,65535,65535.

The Sample Code

Producing a TIFF writer to incorporate into your own programs is not too difficult. Decide on what kind of image you are going to export, eg uncompressed palette colour, and provide the necessary tags to define it. Producing a really general TIFF reader is a much harder task. For a particular application the range of image types and sources will be limited. This knowledge can be used to simplify the reader so that it deals with images of the appropriate kind and rejects

other ones. The accompanying code, in Figure 6, is a kit of subroutines, in Microsoft C, out of which you should be able to build TIFF readers and writers suitable for many purposes. The interesting bits are:

ReadTiffFile(). This is the principal subroutine of the reader. It reads uncompressed 8-bit palette colour or 24-bit RGB files with the file handle `InFile`, in either Intel or Motorola ordering, into a global array called `Image`. If you are using one of the new 32-bit flat address space compilers such as Watcom C 9.0 or the Intel C CodeBuilder Kit, you will have no difficulty in declaring a big enough array to hold the whole image. For users of 16-bit compilers it will be necessary to doctor references to `Image [ ] [ ]`. For example, the picture could be dealt with in strips, or possibly the data might simply be written to the display device and stored there. Notice that though the subroutine reads palette data into the global array `Palette [ ] [ ]`, it does not reset the hardware palette. This will have to be done by an appropriate subroutine call.

Some TIFF writers seem to ignore the fact that palette data is supposed to be 16 bits and just store 8-bit entries. Treating these as the least significant part of a 16-bit value leads to a palette full of zeros and a display that is comprehensively black. `ReadTiffFile ()` makes the assumption that if the most significant 8 bits are zero, the odds are you have degenerate palette data and attempts a fix by left shifting 8.

ReadPixelRow(). At the present time most of us cannot display 24-bit colour so what to do with it presents a bit of a problem. This subroutine employs a trick which you may find useful. It turns them into 8-bit grey-scale images using the weighting factors used in television to calculate the luminance from the red, green and blue signals. `SetPixel (x, y, p)` places a pixel of value `p` on the screen at location `(x, y)`.

WriteTiffFile(). This is the principal subroutine of the writer. It writes an uncompressed 8-bit palette colour files with the handle `OutFile`, in Intel ordering, from a global array called `Image`. The image size is given by the globals `HRes` and `VRes`, the software palette is in the global `Palette [256] [3]`.

TYPE	BYTES PER VALUE	NUMBER OF VALUES WHICH FIT	NUMBER OF VALUES REQUIRING OFFSET
1 = BYTE	1	4	≥ 5
2 = ASCII	1	4	≥ 5
3 = SHORT	2	2	≥ 3
4 = LONG	4	1	≥ 2
5 = RATIONAL	8	0	≥ 1

Figure 5 - TIFF Data Types

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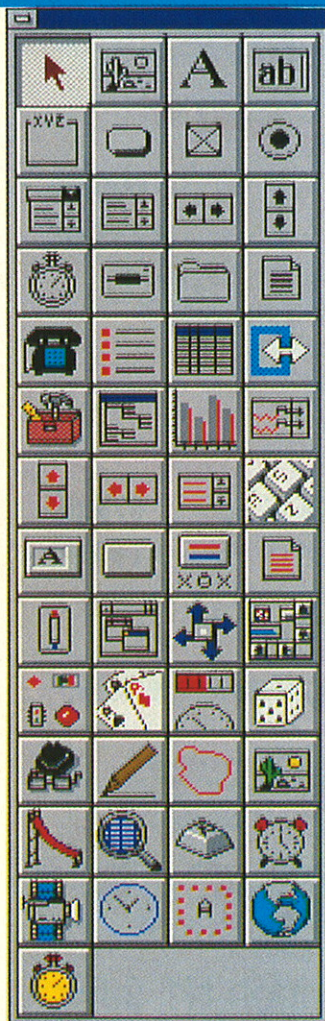
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```

//Subroutines for TIFF readers and writers
#include <io.h> // File I/O functions
#include <stdio.h> // for printf()
#include <string.h> // for strcpy()
#define BYTE unsigned char
#define UINT unsigned int
#define CLAMP(v,l,h) ((v)<(l)?(l):((v)>(h)?(h):(v)))
BYTE Stg[256], // general purpose string
Image[1], // array for holding image
// See text
Palette[256][3]; // software palette
int InFile, OutFile, // file handles
// TIFF globals
BitsPerSample, FirstTag, HRes,
ModeIorM, NTags, PhotometricInterp,
PlanarConfig, SamplesPerPixel,
StartRaster, StartPalette, VRes,
TitleLoc;
// You supply this from a graphics lib
void SetPixel(int x, int y, int col);
void Read1(int handle, BYTE *ch);
void Read2(int handle, UINT *i);
void Read4(int handle, UINT *i);
void ReadHeader(int handle,
int *ifdoffset);
void ReadPixelRow(int inhandle,
int row, int hres);
void ReadTag(int handle, UINT *tag,
UINT *type, UINT *length,
UINT *value);
void ReadTiffFile(void);
void TiffError(BYTE *text);
void Write1(int handle, BYTE ch);
void Write2(int handle, UINT i);
void Write4(int handle, UINT i);
void WriteHeader(int handle);
void WriteTag(int handle, UINT tag,
UINT type, UINT length,
UINT value);
void WriteTiffFile(void);
// =====
void Read1(int handle, BYTE *ch)
{ BYTE buffer[1];
read(handle, buffer, 1); *ch=buffer[0];
}
// =====
void Read2(int handle, UINT *i)
{ BYTE buffer[2];
read(handle, buffer, 2);
if (ModeIorM==0x4949)
*i=buffer[0] | (buffer[1]<<8);
else
*i=buffer[1] | (buffer[0]<<8);
}
// =====
void Read4(int handle, UINT *i)
{ BYTE buffer[4];
read(handle, buffer, 4);
if (ModeIorM==0x4949)
*i=buffer[0] | (buffer[1]<<8) |
(buffer[2]<<16) | (buffer[3]<<24);
else
*i=buffer[3] | (buffer[2]<<8) |
(buffer[1]<<16) | (buffer[0]<<24);
}
// =====
void ReadPixelRow(int inhandle,
int row, int hres)
{ BYTE buffer[4800];
int i, j, n, w;
// for the moment if data is RGB
// deal only with triads
if (PlanarConfig==2) return;
if (PlanarConfig==1)
{ n=read(inhandle, buffer, 3*hres); j=0;
for (i=0; i<n; i+=3)
{ w=CLAMP((299*buffer[i]+
587*buffer[i+1]+
114*buffer[i+2])/1000, 0, 255);
Image[j][row]=w; SetPixel(j, row, w);
j++;
}
}
else
{ n=read(inhandle, buffer, hres);
for (i=0; i<n; i++)
{ w=buffer[i]; Image[i][row]=w;
SetPixel(i, row, w);
}
}
}
// =====
void ReadHeader(int handle, int *ifdoffset)
{ int n;
Read2(handle, &n);
if (n!=42)
TiffError("Input is not a TIFF file");
Read4(handle, ifdoffset);
}
// =====
void ReadTag(int handle, UINT *tag,
UINT *type, UINT *length,
UINT *value)
{ int dummy;
Read2(handle, tag);
Read2(handle, type);
Read4(handle, length);
// allow for reading one
// left justified 16 bit SHORT
if (*type==3 && *length==1)
{ Read2(handle, value);
Read2(handle, &dummy);
}
else
Read4(handle, value);
}
// =====
void ReadTiffFile(void)
{ int b, currenuposinfile, g, i, ifdoffset, j,
length, ntags, pal, r, row,
rasterstart, tag, type, value;
// header
BitsPerSample=HRes=PhotometricInterp=
PlanarConfig=SamplesPerPixel=
StartPalette=VRes=-1;
ReadHeader(InFile, &ifdoffset);
lseek(InFile, ifdoffset, SEEK_SET);
// Tags in directory
Read2(InFile, &ntags);
for (i=0; i<ntags; i++)
{ ReadTag(InFile, &tag, &type, &length, &value);
switch (tag)
{ case 0x100: // Image Width
HRes=value;
break;
case 0x101: // Image Length
VRes=value;
break;
case 0x102: // Bits Per Sample,
if (length==1) // 8 or 24
BitsPerSample=value;
else if (length==3)
{ currenuposinfile=tell(InFile);
lseek(InFile, value, SEEK_SET);
Read2(InFile, &r);
Read2(InFile, &g);
Read2(InFile, &b);
lseek(InFile, currenuposinfile,
SEEK_SET);
if (r==8 && g==8 && b==8)
BitsPerSample=24;
}
if (BitsPerSample==1)
TiffError("Input data must be\
in 8 or 24 bits/pixel format");
break;
case 0x103: // Compression
if (value!=1)
TiffError("Input data must be\
uncompressed");
break;
// Photometric Interpretation
// 2 for RGB if not assume 3
// ie palette colour
case 0x106:
if (value==4)
TiffError("Can't deal with\
transparency masks");
PhotometricInterp=(value==2) ? 2 : 3;
break;
case 0x111: // Strip Offset
// Points to raster data
if (length==1) rasterstart=value;
else
// Image is defined as a set of strips;
// hope that they are consecutive and
// contiguous we can simply find where the
// first one begins and start reading
// from there.
{ currenuposinfile=tell(InFile);
lseek(InFile, value, SEEK_SET);
Read4(InFile, &rasterstart);
lseek(InFile, currenuposin-
file, SEEK_SET);
}
break;
case 0x115: // Samples Per Pixel
// 1 for 8 bits/pixel
// 3 for 24 bits/pixel
if (value==1 || value==3)
SamplesPerPixel=value;
else
TiffError("Input data must have\
1 or 3 samples per pixel");
break;
case 0x11c: // Planar Configuration
// 1 for RGB triad 2 for red plane
// followed by green plane followed
// by blue plane
PlanarConfig=value;
break;
case 0x140: // Colour map offset
StartPalette=value;
break;
default:;
}
}
if (BitsPerSample==1 || HRes==1 ||
VRes==1 || SamplesPerPixel==1 ||
(PlanarConfig==1 &&
SamplesPerPixel>1))
TiffError("Insufficient data in\
TIFF file tags");
// The input TIFF file has a palette
if (StartPalette!=-1)
{ lseek(InFile, StartPalette, SEEK_SET);
for (j=0; j<3; j++)
for (i=0; i<256; i++)
{ Read2(InFile, &pal);
Palette[i][j]=(pal>256) ?
pal : pal<<8;
}
// This trick is necessary, as some
// products (eg PBrush) appear on occasion
// to put the palette info out in the
// range 0-255 rather than 0-65535
}
// reset the hardware palette here
// using the values in Palette[]
}
// raster data
lseek(InFile, rasterstart, SEEK_SET);
for (row=0; row<VRes; row++)
ReadPixelRow(InFile, row, HRes);
close(InFile);
}
// =====
void TiffError(BYTE *text)
{ printf("%s\n", text);
close(InFile); close(OutFile);
}
// =====
void Write1(int handle, BYTE ch)
{ BYTE buffer[1];
buffer[0]=ch<0xff;
write(handle, buffer, 1);
}
// =====
void Write2(int handle, UINT i)
{ BYTE buffer[2];
buffer[0]=i<0xff; buffer[1]=(i>>8)&0xff;
write(handle, buffer, 2);
}
// =====
void Write4(int handle, UINT i)
{ BYTE buffer[4];
buffer[0]=i<0xff; buffer[1]=(i>>8)&0xff;
buffer[2]=(i>>16)&0xff;
buffer[3]=(i>>24)&0xff;
write(handle, buffer, 4);
}
// =====
void WriteHeader(int handle)
{ BYTE notice[32];
int l, n;
strcpy(notice, "Copyright MCMXCII");
// number of tags in directories
NTags=12;
// calculate where things will go
// 4 bytes for MM and 42
TitleLoc=8;
// length of copyright notice
// including the NUL
StartRaster=TitleLoc
+32;
// size of image
StartPalette=StartRaster
+VRes*HRes;
// size of palette, 768 off 2 byte values
FirstTag=StartPalette
+1536;
Write2(handle, 0x4949);
Write2(handle, 0x002a);
Write4(handle, FirstTag);
write(handle, notice, 32);
}
// =====

```

Figure 6 - Sample TIFF subroutines

(Continued on page 40)


```

void WriteTag(int handle,UINT tag,
             UINT type,UINT length,
             UINT value)
{ Write2(handle,tag);
  Write2(handle,type);
  Write4(handle,length);
  switch(type)
  { case 3:
    if (length==1)
    { Write2(handle,value);
      Write2(handle,0);
    }
    else
    Write4(handle,value);
    break;
  case 4: Write4(handle,value);
    break;
  default: Write4(handle,value);
  }
}
// =====
void WriteTiffFile(void)
{ BYTE buffer[2048];
  int c,i,j,r;

  WriteHeader(OutFile);
  // write raster data to file
  lseek(OutFile,StartRaster,SEEK_SET);
  for (r=0;r<VRes;r++)
  { for (c=0;c<HRes;c++)
    buffer[c]=Image[c][r];
    write(OutFile,buffer,HRes);
  }
  // write palette data
  lseek(OutFile,StartPalette,SEEK_SET);
  for (j=0;j<3;j++)
  for (i=0;i<256;i++)
    Write2(OutFile,Palette[i][j]);
  // now write tags etc
  lseek(OutFile,FirstTag,SEEK_SET);
  Write2(OutFile,NTags);
  // NewSubfile, main image
  WriteTag(OutFile,254,0x04,1,0);
  // ImageWidth
  WriteTag(OutFile,0x100,3,1,HRes);
  // ImageLength
  WriteTag(OutFile,0x101,3,1,VRes);
  // BitsPerSample (8)
  WriteTag(OutFile,0x102,3,1,8);

  // Compression (none)
  WriteTag(OutFile,0x103,3,1,1);
  // PhotometricInterp (palette)
  WriteTag(OutFile,0x106,3,1,3);
  // title
  WriteTag(OutFile,0x10e,2,32,TitleLoc);
  // StripOffset, points to where
  // raster data starts
  WriteTag(OutFile,0x111,4,1,StartRaster);
  // SamplesPerPixel (1)
  WriteTag(OutFile,0x115,3,1,1);
  // RowsPerStrip
  WriteTag(OutFile,0x116,4,1,VRes);
  // StripBytesCount
  WriteTag(OutFile,0x117,4,1,HRes*VRes);
  // Colour map offset
  WriteTag(OutFile,0x140,3,768,StartPa-
  lette);
  // no more TIFF stuff
  Write4(OutFile,0);
  close(OutFile);
}

```

Figure 6 - Sample TIFF subroutines (Continued)

WriteHeader(). This subroutine calculates where things are to go in the file and then writes out the TIFF header, allowing for the inclusion of a copyright notice. Just to be different, the image bit map is placed immediately after the copyright notice, the palette after the image and the tags at the end of the file. This emphasises the point that, apart from the first eight bytes, there are no fixed locations in TIFF files. In practice it is probably better to put the tags before the image bit map, especially if the

file will be read off a floppy, otherwise time will be wasted reading down the file for them.

EXE

Dr Graeme Webster was formerly Head of Department of Computer Science and later Deputy Director, Academic, of Teesside Polytechnic. He has been involved with computer graphics for the last 20 years with

an especial interest in 3D visualisation for Designers. Currently he is Senior Research Fellow at Teesside Polytechnic working on image processing linked to expert systems and neural networks.

You typists may obtain this code in machine readable form, plus that from Dr Webster's previous articles, by sending in a disk as per the rules laid out on Page 3, column 1. Please mark your envelopes 'TIFF'.

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A Choice of Weapons

There are many object-oriented development environments which make a Windows programmer's life much easier. Thomas Payne compares two of the most established tools, Actor and Smalltalk V.

When it comes to programming for Windows, there is no doubt that object-oriented (OO) techniques are the best way forward. OO techniques give a quick turn-round in producing Windows applications for the market-place, whether that is internal or external to your organisation. For C programmers the way forward is usually to start using C++. However, there are other object oriented development environments which offer greater productivity than C++ and can produce very sophisticated and complex applications as well as being ideal for developing your application prototypes.

Two of the most popular object-oriented development environments for Windows are Actor and Smalltalk. Both of these provide an integrated environment which allow you to have your application running while changing the underlying code within the application - without having to go through the edit-compile-run cycle typical of most third generation languages.

Smalltalk V for Windows is one of Digitalk's family of Smalltalk V products which covers the DOS, Windows, Presentation Manager and Apple Macintosh environments. Digitalk started its product range with the spe-

cific aim of providing a practical version of Smalltalk, designed to run on PC platforms.

Actor was developed early in the life of Windows by the Whitewater Group (now owned by Symantec), infamous for the Whitewater Resource Toolkit. Only in Windows 3, with its comparative lack of memory constraints, did Actor fulfil its potential. It was designed to be faster and more compact than Smalltalk, while offering the same level of functionality. Actor 4, released in November 91, had some new features which make it easier to trap events and prototype Windows and includes support for SQL databases, Microsoft's help system and multiple inheritance.

Serious Applications

It is a common assumption that these tools are good for developing smaller applications quickly, but are not so good for larger projects. Our experience at ISA contradicts this. The Predictive Insurance Sales Force Model (PRISM) built for Tillinghast (Figure 1), was mainly developed in Actor, with some C modules which performed the computationally intensive vector manipulation which was necessary.

Figure 2 shows the Eve CASE tool (used by ISA, to support the OMT method for object-oriented design and analysis). Eve was written using Smalltalk V for Windows. This application communicates to a SQLBase database through a DLL and enables full documentation for object-oriented systems to be gathered. It can read Smalltalk and Actor files to produce documentation for those systems automatically, with support planned for C++.

Actor and Smalltalk *do* provide good prototyping. But our experience of Actor and Smalltalk agrees with that of several large multinational companies that high-level OO tools are suitable for complex and important applications.

Installation and Setup

Smalltalk comes on a single floppy disk. When installed (using a Windows-based program) it uses just over 2.5 MB of disk space, including all of its example files. Most of Smalltalk is contained in several large DLLs, split into those which support the development environment and those which are base classes, used both in development and run-time applications. Small-

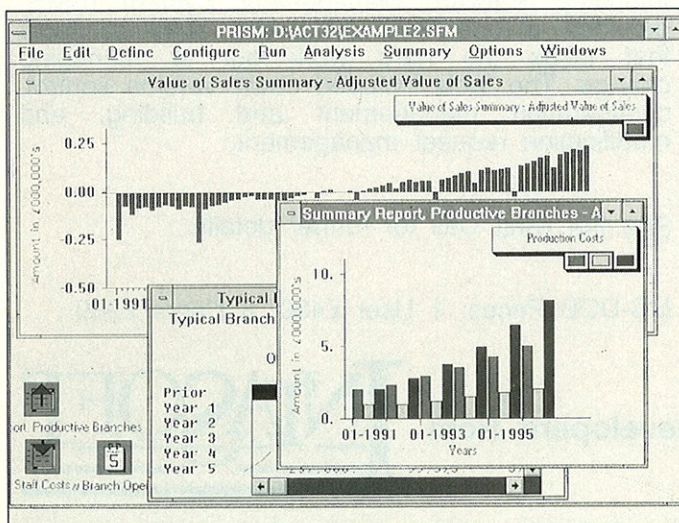


Figure 1 - PRISM, written in Actor

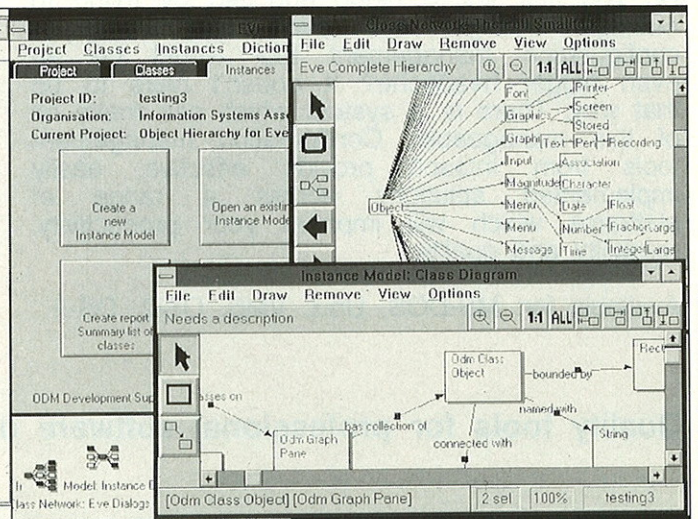
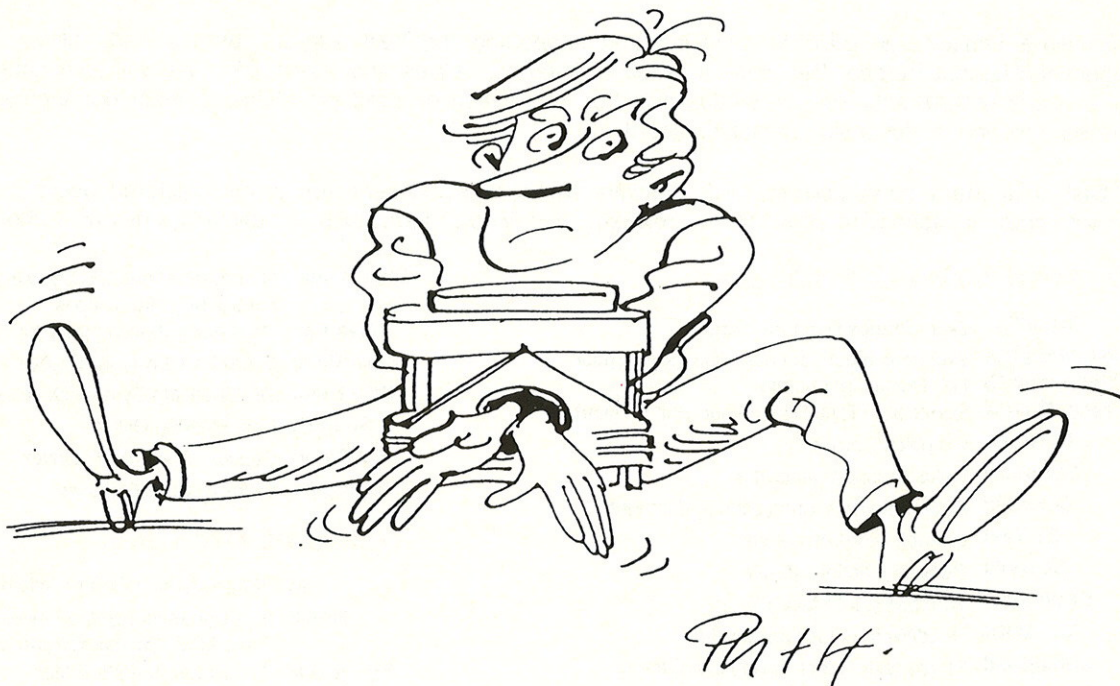


Figure 2 - The Eve CASE tool, written in Smalltalk V

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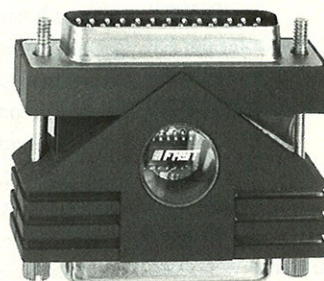
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talk V's development environment uses approx 1.5 MB of Windows memory; applications use upwards of about 1 MB.

Actor also has a Windows installation routine, which gives you the choice of how much to copy across. Installing the whole lot requires about 8 MB of disk space, although the core Actor system including the Object Windows Library (OWL) will only take up 2.5MB of disk space. Actor only needs two files to run, ACTOR.EXE and the image file ACTOR.IMA (the other files are all part of the development environment).

The Actor program is much smaller than Smalltalk with all its DLLs and thus uses a minimum of 500 KB depending upon the static and dynamic memory settings you use (see memory management). This means Actor can run on a 286 with 2 MB of RAM, whereas Smalltalk needs a much more powerful machine.

Ease of learning

The syntax for both languages is fairly simple, partly because everything in both systems is an object. The main learning curve asso-

ciated with both environments is learning the class hierarchies upon which they have been built and the methods belonging to those classes. Once these have been mastered, Windows applications can be generated extremely quickly within each of the environments. The code shown in Figures 3 and 4 creates a simple editor comparable to Windows Notepad, without the limitation on file size. In both cases, it only takes one or two lines of code to create these editors.

For people not used to the idea of OO programming, Smalltalk's syntax can look a bit odd. The code example in Figure 3 creates an editor and adds some initial text. In the first line we create and show a window, by sending the message `windowLabeled: 'xxx'` frame: `aRectangle` and assign it to the global variable `Fred`. The following lines add text to this window. The syntax is very simple, as absolutely everything in Smalltalk is an object to which messages get sent. Even control constructs, such as looping statements, if statements and iteration, are implemented as methods within Smalltalk. All you need to know is where to put full stops and commas in your code. Iteration, or looping over an array, collection (list), dictionary or string, is performed with 'do' messages. It is difficult to appreciate how useful these messages are until you have actually used them.

Actor's syntax is a cross between Pascal and C. Messages are sent to objects in a similar way to function calls in C, where the first argument in the list is the receiving object. The equivalent code used to create a simple text editor with some initial text is shown in Figure 4. Actor has its control constructs within its syntax such as if/else, select (for case statements) and one looping construct. However, iteration over arrays and collections is programmed by sending the 'do' message to an object in the same way as Smalltalk. The syntax within Actor has been deliberately designed to be familiar to 3GL programmers.

Development environments

Code within Smalltalk and Actor is written in a browser. Class browsers list all the classes, in a hierarchical fashion, and all of the methods and variables associated to those classes. Methods are compiled individually and added to the image (your currently compiled code). Browsers allow you to compile your code incrementally and also let you see, and more importantly change, all the code that has been written to develop the programming environment and the system's base classes. Within the browsers you can find many a short-cut for developing your applications - the browsers are often more informative than the

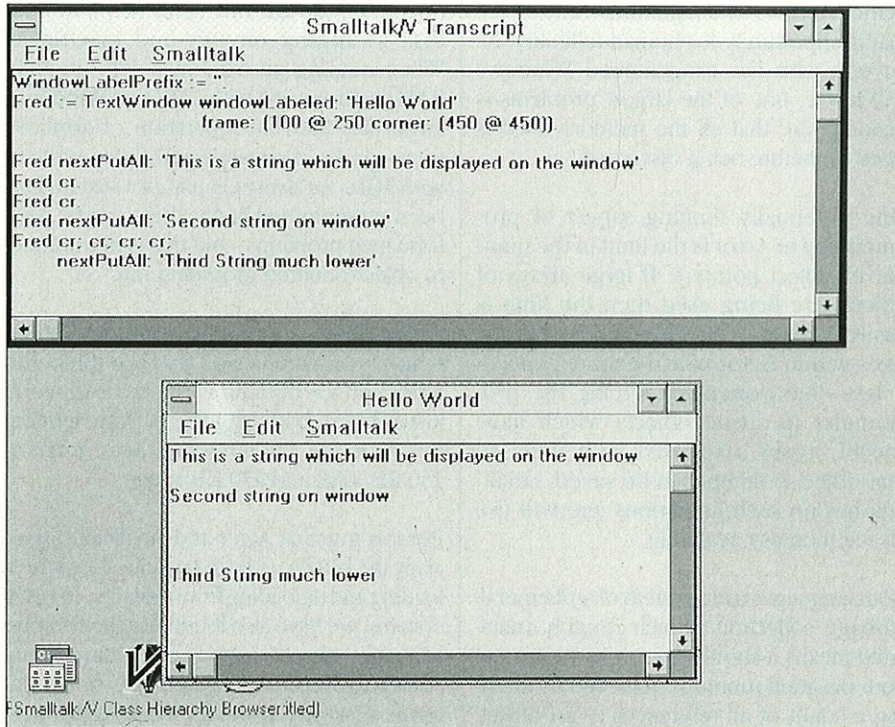


Figure 3 - Creating a text editor in the Smalltalk workspace

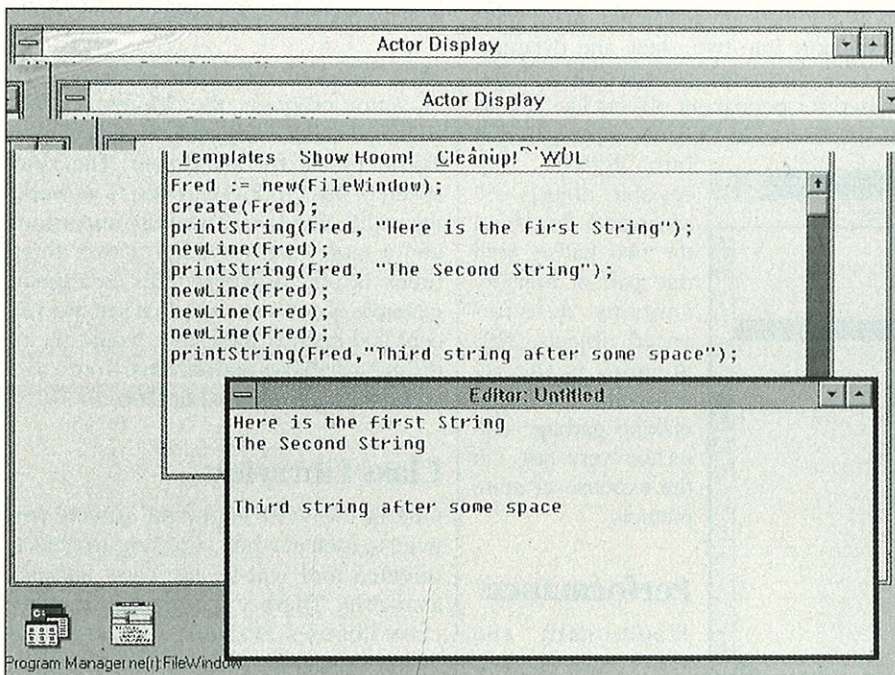


Figure 4 - Creating a text editor in Actor's workspace

documentation. The way browsers are used in both languages strongly supports the concept of code reuse.

An important feature of both Actor and Smalltalk is their 'work windows'. You can type directly into these to test code fragments or run your application within the development environment. This is a very useful way to test how objects work, both those within the system and those which you are creating yourself. For people not familiar with the Windows SDK (hands up those who can recall all 600 calls from memory), this is a great boon, especially in Actor where the brave can type an SDK call at the work window and immediately see its effect. An important feature of fully interactive environments is that much more of your time is spent programming rather than compiling. When switching from Actor or Smalltalk to C or C++, I find it very frustrating having to compile an application just to test out small code fragments.

Also integrated within your environment are debuggers and inspectors. The debuggers appear either when an error occurs or when you insert a break in your code. They allow you to browse the current execution stack and look at the state of any of the objects and their instance variables. Inspectors are used for looking at the objects and their instance variables. You can change the value of an instance variable, if needed, before resuming execution of your program. The debugger not only allows you to see the current methods being executed but also enables you to change those methods on the fly. This makes the programmer's life much easier.

Although Smalltalk and Actor both have debuggers, the Smalltalk debugger allows you to step through execution of the code and thus enables the errors to be tracked

down more easily than within the Actor's debugger.

Memory Management

One of the greatest advantages with both Smalltalk and Actor is their automatic memory management facilities. Both have dynamic garbage collection, which means the programmer does not have to worry about allocating and freeing memory associated to the objects in the system. This can save a huge amount of time, both during development and later in the life cycle, as automatic memory management removes a major opportunity for human fallibility. As anyone who has programmed Windows will know, one of the largest problems is making sure that all the memory used is freed up before being discarded.

One potentially limiting aspect of programming in Actor is the limit in the number of object pointers. If large arrays of objects are being used then the limit is easily reached. This gives rise to various fixes within Actor which generally make it less object-oriented, forcing the programmer to create objects which have specific types associated with them so that object pointers can be saved. Smalltalk has no such limitations and will use all the memory available.

Both languages use a system of 'ephemeral' garbage collection (which roughly translated means it should not get in the way of your program running), achieved by keeping a count of all references to an object. When the count becomes zero, the object cannot be referenced, so its allocated memory is automatically reclaimed. Actor splits its memory into two, static and dynamic. Static memory is not garbage collected, and is used for permanent objects like classes and method code. Dynamic memory is split

into halves. Accessible objects are swapped between the two halves until one part of memory contains de-referenced objects. This memory is the reclaimed in one go, making garbage collection very fast - at the expense of more memory.

Performance

Traditionally the sheer novelty of high-level OO tools has been enough to

scare off many 'serious' developers. Now that these 'novel' concepts have been adopted by respectable vendors this is less the case, but two big concerns still remain - speed and size. If size of executable and all round performance are more important to you than development and maintenance costs, then you should stay with 3GLs. But if you have even a little leeway, Actor and Smalltalk become viable. They both outperform 4GL tools like Omnis and Visual Basic.

Both Actor and Smalltalk can be slow in operation, though this tends to be due to disk swapping on low-end machines. When running on machines with enough RAM (such as a 386 with 4 MB and Windows swap file) then the operation of applications can be comparable to those written with 3GLs. As always, if part of a system has been programmed badly, there can be performance problems - but this is not unique to object-oriented programming.

Object Draw, a demonstration application which is delivered with Object Graphics for Actor and for Borland C++, seems to work just as fast in both languages. Draw written in C++ is 408 KB; written in Actor it has a 150 KB .EXE and 470 KB image.

But it is true that Actor and Smalltalk (especially the latter) can both be quite slow when loading and unloading from memory. In large systems, we have also found that the computationally intensive parts of a program can run slowly. However, as these parts can be rewritten as a DLL in a lower level language, there are generally no problems with the final applications. User interface code within these systems performs acceptably.

Many Windows programmers have used an Actor program: the Whitewater Resource Toolkit (originally bundled with Turbo Pascal for Windows). The slow speed of this product was due to its working within Windows 2 memory restrictions and a more recent version is over three times faster. However, this is a good example of software which, if just five per cent had been written in C, would be indistinguishable in performance from a tool written completely in C or C++.

Class Libraries

One of the most important aspects you need to look at when choosing an object-oriented tool will be the class libraries available. There are many third party class libraries available for Actor and Smalltalk, either purchasable from various suppliers or downloaded from bulletin boards.

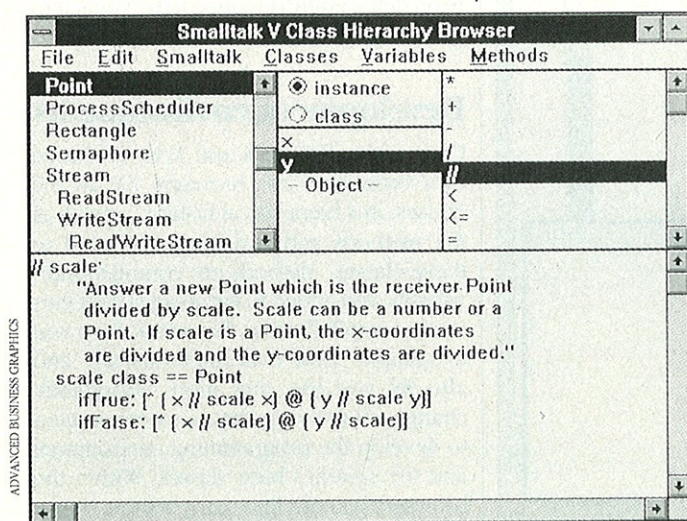


Figure 5 - Smalltalk's Class Browser

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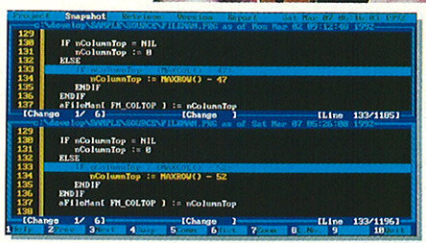
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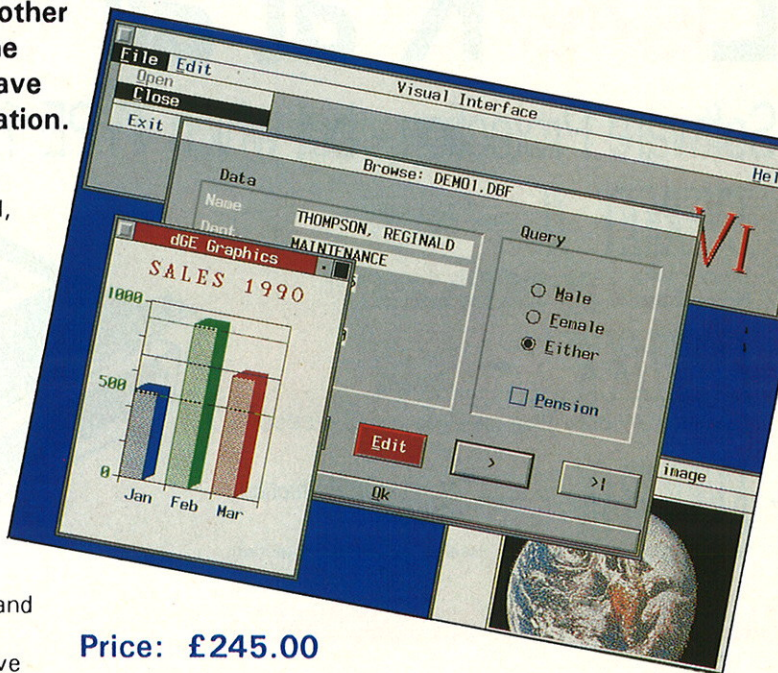
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Actor comes with a comprehensive set of class libraries with its distribution. Its Windows class library is based on Object Windows Library (OWL) - as supplied with Borland's C++ - which should enable you to move your applications from Actor to C++ if necessary. Supplied with Actor is Object Graphics, a class library which encapsulates the Windows GDI, and a class library for interfacing to SQL databases. This currently uses Pioneer's Q+E DLL, enabling xBASE applications to be built simply within Actor. Each of these class libraries comes with its own documentation.

Smalltalk does not come with any major 'addon' class libraries. However there are many third party class libraries available. Of note is WindowBuilder which adds a Visual Basic style interface onto Smalltalk allowing windows to be built graphically, with the events being programmed for the objects placed on the screen. WindowBuilder can also be extended easily to add control classes which you have developed as well as the core Smalltalk classes. There is also a SQL set of classes which uses the Techgnosis SequelLink product, allowing interfaces to many different back end databases. One of the best class libraries is the Envy/Developer product which helps manage multiple developer pro-

jects and manages the version control for the application. This is a particularly important product, because neither Actor or Smalltalk projects are easy to manage with more than two or three programmers.

Conclusion

Both Actor and Smalltalk will enable you to develop complex Windows applications more quickly than using a 3GL, such as C, Pascal or C++. Because you can make direct calls to the API, they do not lose any Windows functionality - as is the case with many restrictive 4GLs. 4GL tools will always remain the best solution for the types of application for which they have been developed, unless the functionality needs extending.

The main differences between Smalltalk and Actor are the ways in which the class libraries work. Both are extremely productive and enable quick development of Windows applications. Actor currently has better class libraries and produces smaller executables and images than Smalltalk, although Smalltalk produces much more portable code if you are intending to develop for other platforms. There is more third-party support for Smalltalk.

At the end of the day, choice of development tool is dependent upon the type of application you want to build. If all my Windows applications were straightforward database front ends, I would pick a respectable 4GL tool. For small to medium general-purpose systems - say a small application which need whizzy graphics and stored data in dBase files - I would choose to use Actor, especially if the application needs to run on relatively low-end machines. If the system was much larger, needing multiple programmers and handling large amounts of data, I would use Smalltalk. And for low-level register access, memory control, tight executables and high speed, I still need C and C++.

EXE

Thomas Payne works for Information Systems Associates (081 993 8080) and has programmed Windows application with Actor, Smalltalk and C++.

Actor has an RRP of £179 for the plain vanilla version, or £349 for 'Actor Professional' described here - contact a dealer for information. Smalltalk V for Windows costs £330 from Cocking and Drury (071 436 9481).

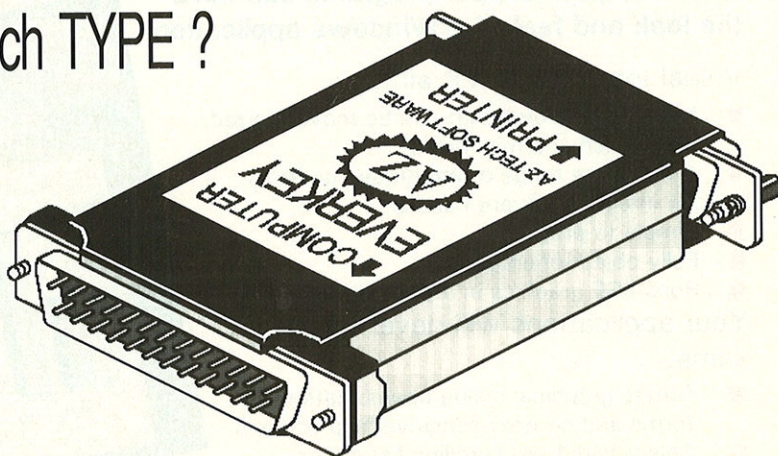
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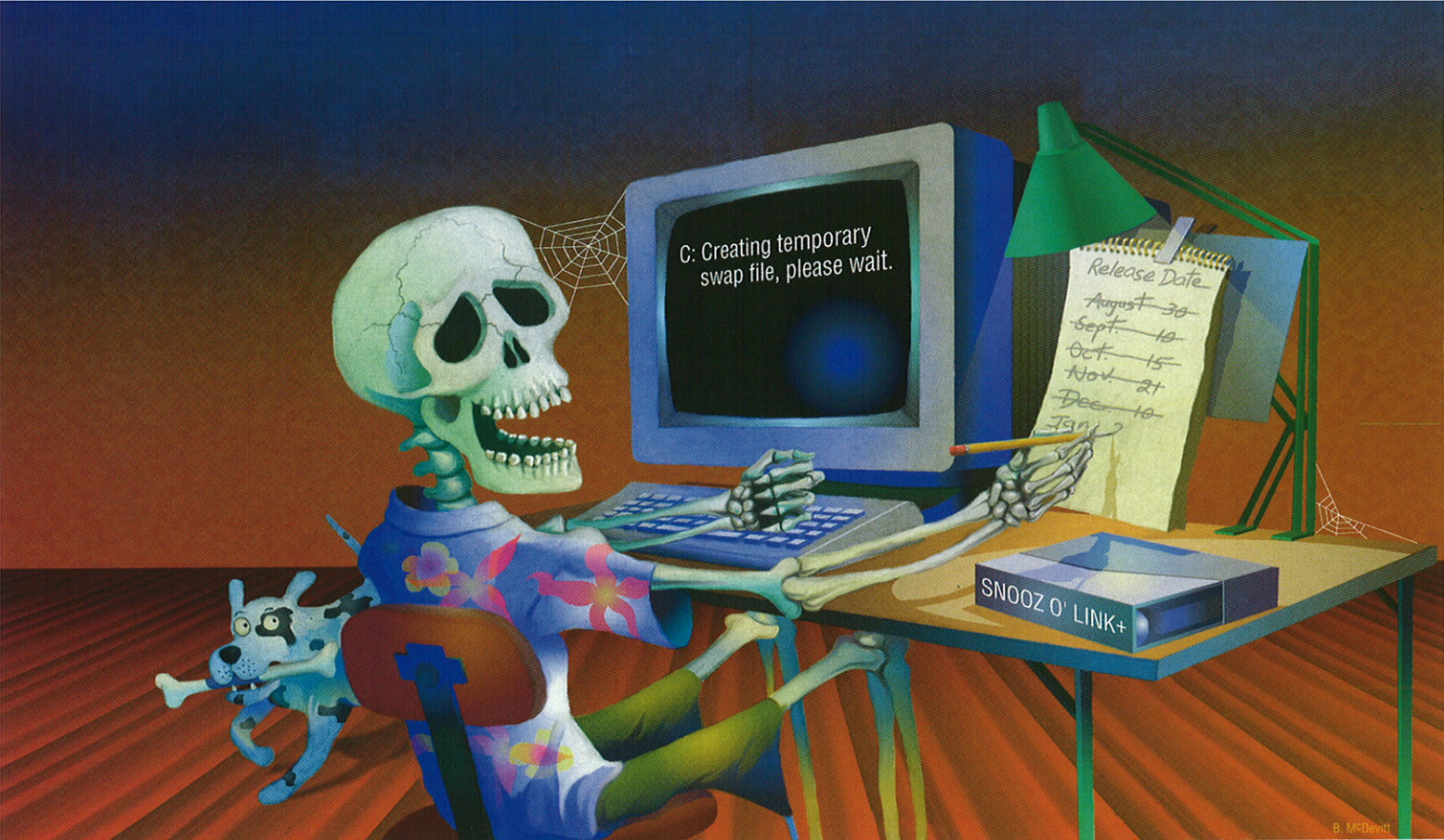


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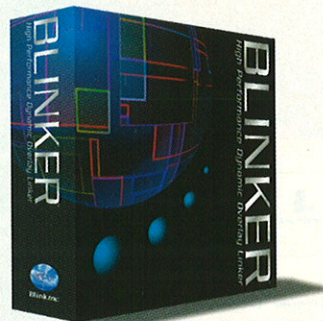
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climbs inside UNIX and tinkers with the async drivers.*

The UNIX community has its fair share of bores - bearded folk with beer bellies and T-shirts who look like parodies of Bjarne Stroustrup. You know, the sort of people who wear fawn coloured socks under open-toed sandals. (*What wrong with this? - Ed.*)

They have developed and enforced an elaborate series of rules and regulations regarding what you can and can't do in UNIX, and usually defend this position by saying something like 'Well, er Roger, I think you will find it axiomatic in UNIX that we build on the work of others'. Never trust a man who uses the word 'axiomatic', or calls you Roger when your name is Richard, that's what I say.

Unfortunately, when you want to break out of UNIX and connect it to something else, there is no work of others. 'Why on earth should you want to?', the bores reply and turn once more to their terminals.

Fortunately, the designers of UNIX are older and wiser than their bearded followers and devised the general terminal interface (termio) which provides a generalised and portable set of rules for driving attached async devices. Unfortunately, the description of its use is, as usual, spread all over the documentation.

So, tie down your system administrator and let's look at DIY async communications in UNIX.

The Teletype Drivers

This is where it all starts. The teletype drivers are located in `/dev/ttys` and are called 'ttnn', where 'nn' is the port number that they address. The world has moved on from teletypes but UNIX keeps the faith. A teletype, for those of you who have never seen one, was a cross between a typewriter and a toilet roll - a sort of character-oriented proto-Fax.

It is possible to open the driver for a specified port as a device file and read from it and write to it under program control. The trick is to stop other processes doing the same. Using `ioctl` calls, you can reset the driver to

change the baud rate, character framing, parity etc. The manuals all assume that you want to do this to drive a new sort of screen and keyboard (terminal) on your system, but the above holds true for async modems too.

init-getty-login-shell

UNIX was born connected by an umbilical cord to a teletype and the UNIX kernel is usually sysgened with async terminal interrupt handlers. When UNIX boots, amongst other things, it spawns a process called `init` that reads the contents of a file and if one has been defined, spawns a specific process for each port. Normally `init` spawns the `getty` process and hands it a device file name and a mode as arguments. `getty` opens this device file three times and maps it to the standard input, output and error files. It looks up the mode argument in `/etc/gettydefs`, initialises the device and spawns the `login` process with a user name. Having validated a user's name and password, `login` spawns the appropriate shell.

AT&T refers to this rather wearily as the `init-getty-login-shell` sequence and has recently made some changes to it in UNIX V release 4.

In order to get at the hardware directly, we need to stop a lot of this happening. Predictably, UNIX and XENIX do things differently, but the general principles are the same - you need to modify the file that `init` uses and stop it loading `getty` for the port that you are about to use. This, of course, breaches UNIX security and you are not supposed to do it. I hope that you used strong rope to restrain your system administrator.

Nobbling getty

Under UNIX, the `init` process reads a file called `/etc/inittab`. This file allows the system administrator to define a specific process name to be spawned on a specific port at boot time - it may not necessarily be `getty`. To stop `init` spawning this process, obtain superuser permissions and change 'respawn' to 'off' in that port's entry in `/etc/inittab`. Save the modified

Description of termio ioctl calls and commands

The primary termio `ioctl` system calls have the form :

`ioctl(fildes, command, arg)`

`struct termio *arg;`

The commands that use this form are :

TCGETA	Gets the parameters associated with a device file and stores them in the termio structure pointed to by arg.
TCSETA	Sets the parameters from the termio structure pointed to by arg. The change is immediate.
TCSETAW	Waits for any output to flush before setting the new parameters. This form should be used when changing parameters that will affect the output.
TCSETAF	Waits for the output to drain, then flushes the input queue and sets the new parameters.

Three further termio `ioctl` system calls have the form :

`ioctl(fildes, command, arg)`

`int arg;`

The commands that use this form are;

TCSBRK	Waits for the output to drain. If arg is 0, then sends a break (zero bits for 0.25 seconds).
TCXONC	Start / Stop control. If arg is 0, suspends output; if 1, restarts suspended output.
TCFLSH	If arg is 0, flushes the input queue; if 1, flushes the output queue; if 2, flushes both.

Figure 1 - termio `ioctl` system calls

file to disk and type `init -q` at the shell prompt to get `init` to reread `inittab` and re-initialise the port that you are interested in.

XENIX was built from UNIX version 7 and will either spawn `getty` or not. It keeps its port list in a file called `/etc/ttys`. To stop `getty` loading for a port in XENIX, change the first character for that port's entry in `/devs/ttys` from an ASCII value one to a zero. The XENIX specific processes `enable` and `disable` are used to do this when you are in multi-user mode. SCO says that this will change as XENIX is further merged with UNIX.

Having disabled the processes on a particular port, it is now possible to open the port directly and talk to it without anything else getting in our way and generally making a nuisance of itself with unreasonable demands for login names, passwords etc. To talk to the port, all you have to do is open the appropriate device file and write to it or read from it in the usual way. Note that group and ownership rules apply for opening device files.

Using termio

To use `termio`, open a device file and use the `ioctl` system call to interact with the drivers (Figure 1). The `termio` structure is defined in `termio.h` and should be

included in your program.

Most of the `termio` structure consists of bit fields. Individual bits in the fields are ORed to turn a function on or ANDed to turn it off. Multiple settings are ORed together. The ones complement is formed for bits to be ANDed off. See `open-Port (port)` in the code that follows for an example.

The new settings are enforced by using an `ioctl` call with the command `TCSETA` or `TCSETAF`. It is sensible to save the initial `termio` settings and restore them at the end of your program.

In its time, UNIX has obviously been connected to some ropy old terminals and the `termio` interface has to carry a lot of baggage - eg the number of tenths of seconds the system has to wait to allow an electromechanical device to strike a piece of paper.

For the purposes of readability and brevity, I shall only discuss the more interesting settings in `termio`. I take my text from the *SCO XENIX User's Guide*, Miscellaneous Section, `TERMIO(M)`. And verily the keepers of the UNIX were abroad, and spake unto us.

c_iflag. If `IGNBRK` is set, the break condition (a character framing error with data all zeros) is ignored, that is, a character is not put on the input queue and therefore

CBAUD	baud rate:
B0	hang up
B50	50 Baud
B75	75 Baud
B110	110 Baud
B134	134.5 Baud
B150	150 Baud
B200	200 Baud
B300	300 Baud
B600	600 Baud
B1200	1200 Baud
B1800	1800 Baud
B2400	2400 Baud
B4800	4800 Baud
B9600	9600 Baud
EXTA	external A
EXTB	external B
CSIZE	character size :
CS5	5 bits
CS6	6 bits
CS7	7 bits
CS8	8 bits
CSTOPB	send 2 stop bits else 1
CREAD	enables receiver
PARENB	parity enable
PARODD	odd parity, else even
HUPCL	hang up on clear
CLOCAL	local line, else dial up
LOBLK	block layer output

Figure 3 - The `c_cflag` field

is not available for any process to read. If `BRKINT` is set the break condition will generate an interrupt signal and flush both the input and output queues.

`PARMRK` marks parity errors. If `PARMRK` is set, any characters received with parity errors are inserted into the input queue as a three character sequence; `\xFF`, `\x0`, `\xX`, where 'X' is the value of the character received. To avoid ambiguity, if `ISTRIP` is not set, a valid `\xFF` character is inserted into the input queue as the two character sequence `\xFF`, `\xFF`. If `PARMRK` and `IGNPAR` are not set, characters with parity of framing errors are returned as `NULL`.

`IXON` enables `XON/XOFF` output flow control. A received `XOFF` character will suspend output until an `XON` character is received. All `XON/XOFF` characters are discarded. If `IXANY` is set, any character received will restart output.

If `IXOFF` is set, the system will transmit `XON` characters when the input queue is nearly empty and `XOFF` characters when it is nearly full.

If `CTSFLOW` or `RTSFLOW` are set, `IXON` and `IXANY` can also be set so that these two types of flow control do not interfere with each other.

c_oflag. There are no interesting bits in `c_oflag`; just make sure that `OPOST` is not set.

`c_iflag` describes the basic terminal input control

<code>IGNBRK</code>	sets the port to ignore break condition.
<code>BRKINT</code>	signals the interrupt semaphore on receipt of a break.
<code>IGNPAR</code>	ignores characters with parity errors.
<code>PARMRK</code>	marks parity errors
<code>INPCK</code>	enables input parity check
<code>ISTRIP</code>	strips characters of the 8th bit
<code>INLCR</code>	maps NL to CR on input
<code>IGNCR</code>	ignores CR
<code>ICRNL</code>	maps NL to CR on input
<code>IUCLC</code>	maps UPPERCASE to lowercase on input
<code>IXON</code>	enables XON/XOFF flow control
<code>IXANY</code>	enables any character to restart output
<code>IXOFF</code>	enables XON/XOFF flow control on input
<code>CTSFLOW</code>	enables CTS flow control
<code>RTSFLOW</code>	enables RTS flow control

`c_oflag` specifies the system treatment of output

<code>OPOST</code>	postprocesses output
<code>OLCUC</code>	maps lowercase to UPPERCASE on output
<code>ONLCR</code>	maps NL to CR-NL on output
<code>OCRNL</code>	maps CR to NL on output
<code>ONOCR</code>	no CR output at column 0
<code>ONLRET</code>	NL perform CR function
<code>OFILL</code>	uses fill characters for delay
<code>OFDEL</code>	fills in DEL else <code>NULL</code>
<code>NLDLY</code>	selects newline delays
<code>CRDLY</code>	selects carriage return delays
<code>TABDLY</code>	selects horizontal tab delays
<code>TAB3</code>	expands tabs to spaces
<code>BSDLY</code>	selects backspace delay
<code>VTDLY</code>	selects vertical tab delays
<code>FFDLY</code>	selects form feed delays

Figure 2 - The `c_iflag` and `c_oflag` fields

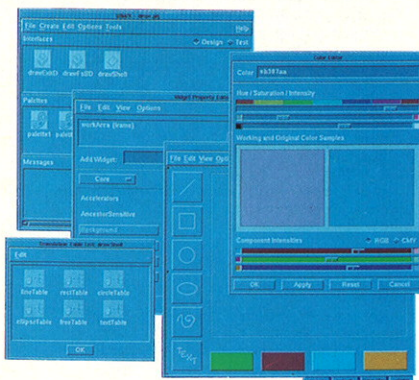
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c_cflag. The CBAUD bits (Figure 3) specify the Baud rate. B0 is used to hang up the connection by dropping DTR.

The CSIZE bits specify the character size in bits for both transmission and reception. This size does not include the parity bit, if any. If CSTOPB is set, 2 stop bits are used otherwise 1 stop bit. For example, at 110 Baud, 2 stop bits are required.

If PARENB is set, parity generation and detection is enabled and a parity bit is added to each character. If parity is enabled the PARODD flag specifies odd parity if set, otherwise parity is even.

If CREAD is set, the receiver is enabled. Otherwise characters received will be discarded.

If HUPCL (Hang up on clear) is set, the line will be disconnected when the last process with the line open closes it or terminates. That is, DTR will not be asserted.

If CLOCAL is set, the line is assumed to be a direct connection with no hardware flow control. The DTR and RTS signals are asserted but incoming signals are ignored. If CLOCAL is not set, hardware flow control is assumed. DTR

c_lflag is used by the line discipline to control terminal functions.

ISIG	enables signals
ICANON	enables canonical input processing
XCASE	enables canonical upper / lower presentation
ECHO	enables echo
ECHOE	echoes erase character as BS-SP-BS
ECHOK	echoes NL after kill character
ECHONL	echoes NL
NOFLSH	disables flush after interrupt or quit
XCLUDE	exclusive use of line

The array c_cc[NCC] contains control characters, most UNIX implementations have more than the 8 listed below.

c_cc[0]	VINTR	DEL
c_cc[1]	VQUIT	FS
c_cc[2]	VERASE	Ctrl-H
c_cc[3]	VKILL	Ctrl-U
c_cc[4]	VEOF/VMIN	EOT
c_cc[5]	VEOL/VTIME	NUL
c_cc[6]	Reserved	
c_cc[7]	VSWITCH	NUL

Figure 4 - The c_lflag field and c_cc[NCC] array

and RTS are asserted and DCD must be high before communications can proceed.

LOBLK, er, the manual descends into heavy gobbledegook here.

The initial hardware control value after open is B9600, CS8, CREAD and HUPCL.

c_lflag. If ISIG is set (see figure 4), each input character is checked against the special control characters INTR, SWTCH

and QUIT. If an input character matches one of these control characters, the function associated with that character is performed. If ISIG is not set, no checking is done.

If ICANON is set, canonical processing is enabled. This enables the erase and kill edit functions and the assembly of input characters into lines delimited by NL, EOF and EOL. If ICANON is not set, read requests are satisfied directly from the input queue.

```

/*
Async Modem Driving Software
Written by Richard Samworth
*/
#include <fcntl.h>
#include <stdio.h>
#include <signal.h>
#include <time.h>
#include <termio.h>
#include <sys/ioctl.h>

#define MAXLINE 80 /* input line length */
extern int errno;
static struct termio term;
static struct termio oldterm;
int fd = -1; /* device file descriptor */
char buf[5120]; /* modemRead buffer */
int bp = 0; /* NEVER checked for */
int hp = 0; /* overflow */
char commsPort[80]; /* Comms Port name */
char *cpp = commsPort; /* and its pointer */
int debug = 0; /* Debug On/Off flag */
char *keywords[6]; /* Command keywords */
int len[6]; /* Their lengths */
int maxkeys = 6; /* And their number */
int timeout = 1; /* Global timeout flag */
/* ***** Modem Control */
disconnect()
/* Wait one second, then re-set the
modem to command mode and tell it
to go on hook. */
{
waitSecs(1);
/* modem to COMMAND mode */
write(fd, "+++", 3);
waitFor("OK", 3);
/* Go ON hook */
writeModem("ATH");
waitSecs(1);
}

openPort(port)
char *port;
/* Open the comms port, then use termio
to set Baud rate etc. Re-open the port
on a new fd and close the old one.
Variable fd contains -1 if this
didn't work. */
{
int i;
fd = open(port, O_RDWR | O_NDELAY);
if (fd != -1)
{ /* Save initial settings */
saveMode();
}
}

```

```

i = ioctl(fd, TCGETA, &term);
/* Set terms and conditions */
term.c_cflag &= ~(CBAUD | HUPCL);
term.c_cflag |= B9600 | HUPCL;
term.c_lflag |= ISTRIP | IGNBRK |
IXON | IXOFF | IXANY;
term.c_lflag &= ~(ISIG | ICANON
| ECHO);

term.c_cc[VMIN] = '\1';
term.c_cc[VTIME] = '\0';
i = ioctl(fd, TCSETAF, &term);
i = fd;
/* re-open port with new conditions */
fd = open(port, O_RDWR | O_NDELAY);
close(i);
}

saveMode()
/* Save the tty modes on entry to the
program. Should be called before
resorting to termio or resetMode. */
{
ioctl(fd, TCGETA, &oldterm);
}

resetMode()
/* Restore the terminal control settings
to those that were in force before
saveMode() was last called. */
/*
{
ioctl(fd, TCSETAF, &oldterm);
}

writeModem(s)
char *s;
/* Write string pointed to by s to the
Modem followed by CR. The call to
write(s) returns the number of chars
written, which is not necessarily 1,
as the kernel is allowed to discard
the character if, for instance, there
aren't any free clists to put it in. */
{
char c, d;
while(*s)
{
if ((c=write(fd, s, 1)) != 1)
{
while ((c=write(fd, s, 1)) != 1);
}
s++;
}
write(fd, "\r", 1);
}

```

```

readModem(bp)
int bp;
/* reads the modem and returns the number
of characters available. */
{
char c;
int i = 0;
while(read(fd, &c, 1) == 1)
{
c = c & 0x7f; /* AND off top bit */
buf[bp++] = toupper((int)c);
i++;
}
buf[bp] = '\0';
return(i);
}

/****** File parser */

parse(s, token)
char *s;
int token;
/* Parses the contents of string pointed
to by s using arrays keywords and len
for a keyword[n] of length len[n] for
maxkeys entries.
Returns a token */
{
char *p = s;
int count = 1;
token = -1;
while (*p) /* Convert to UPPERCASE */
*p++ = toupper(*p);
p = s;
/* strip leading spaces etc */
while((int)*p < 65)
p++;
while (count < maxkeys + 1)
{
if(strncmp(p, keywords[count],
len[count]) == 0)
{
token = count;
return(token);
}
count++;
}
return(token);
}

doIt(s, token)
char *s;
int token;
/* do whatever command we have just
found.
(Continued on page 57)

```

Figure 5 - An application using the general terminal interface



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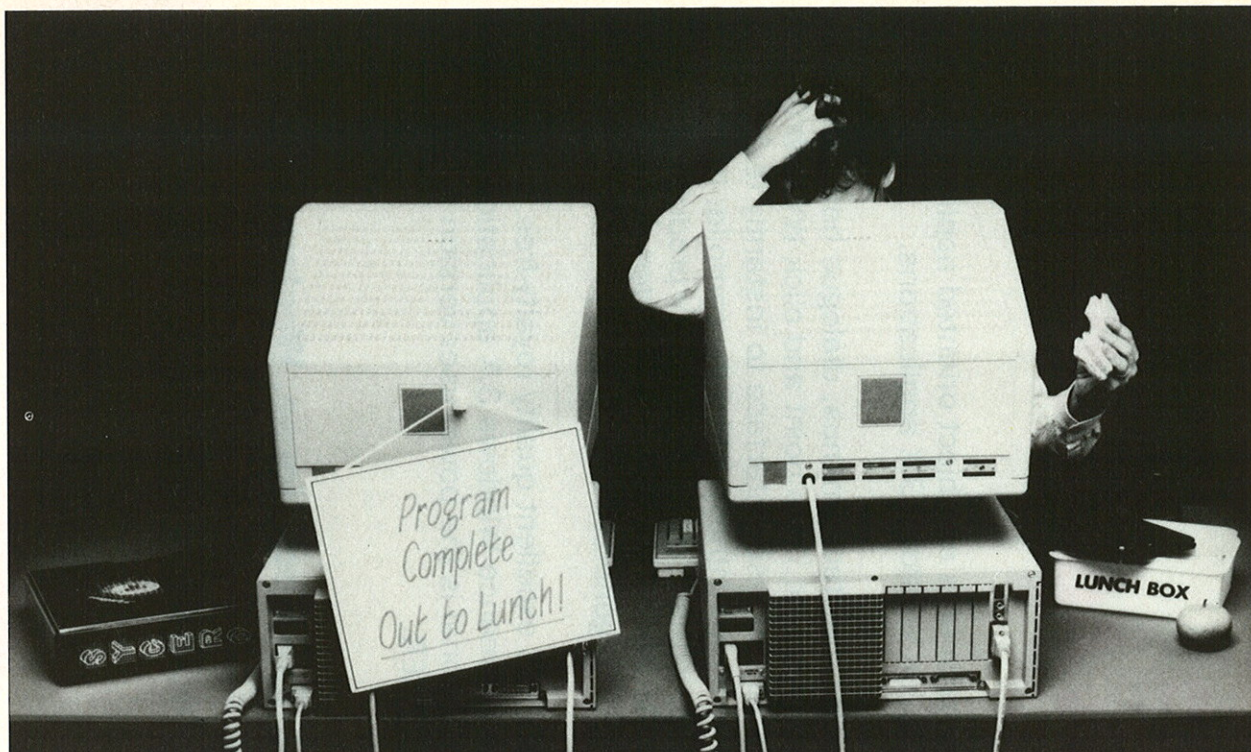
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```

{
    char arg[80];
    char *a = arg, *p;
    long delay = 0; /* Secs to delay */
    static long timer = 60;
    int code = 1; /* Return code */
    if (getArgs(s, a) > 0)
    {
        switch(token)
        {
            case 1:
                sscanf(a, "%d", &delay);
                waitSecs(delay);
                break;
            case 2:
                writeModem(a);
                break;
            case 3:
                code = waitFor(a, timer);
                break;
            case 4:
                sscanf(a, "%d", &timer);
                break;
            case 5:
                p = a;
                while(*p)
                {
                    *p++ = tolower(*p);
                    sscanf(a, "%s", cpp);
                    openPort(cpp);
                    if (fd < 0)
                        code = -3;
                    break;
                }
            return(code);
        }
        getArgs(s, a);
        char *s, *a;
        /* Get the argument(s) from this
        command string.
        Return 1 if successful, -1 if end of
        string before valid delimiter. */
        {
            char *p = s;
            char quote = 0x22;
            int i = 1;
            /* Scan for first quote */
            while (*p != quote)
            {
                i++; /* Checking bounds */
                if (i > MAXLINE - 1)
                    return(-1);
                p++;
            }
            i = 1;
            /* Scan for second quote */
            while (*++p != quote)
            {
                i++;
                if (i > MAXLINE - 1)
                    return(-1);
                *a++ = *p; /* copying string s to a */
            }
            *a = 0;
            return(1);
        }
        waitSecs(s);
        long s;
    }

    /* Wait for s seconds. */
    {
        long t1, t2;
        time(&t1);
        t2 = t1 + s;
        while (t2 > t1)
            time(&t1);
    }
    waitFor(s, t)
    char *s;
    long t;
    /* Reads characters from the line and
    places them in a buffer which is
    scanned for string s from position hp.
    This is, of course, case sensitive.
    Returns 1 if seen, -2 if timeout */
    {
        long t1, t2;
        int count;
        char *h = buf;
        h = h + hp;
        time(&t1);
        t2 = t1 + t;
        while (t2 > t1)
        {
            count = readModem(bp);
            if (count > 0)
            {
                bp = bp + count;
                if ((count = substr(s, h)) != -1)
                {
                    hp = hp + count;
                    return(1);
                }
            }
            time(&t1);
        }
        timeout = -2; /* Timed out, flag it */
        return(-2); /* and return it */
    }

    substr(s, l)
    char *s;
    register char *l;
    /* Checks for the presence of the string
    pointed to by s somewhere within the
    string pointed to by l.
    Returns offset into l if found,
    -1 if not. */
    {
        int length;
        char *lo = l;
        length = strlen(s);
        while ((l = strchr(l, *s)) != 0)
        {
            if (strncmp(s, l, length) == 0)
                return((l - lo) + length);
            l++;
        }
        return(-1);
    }

    /****** Application */
    dialNum()
    /* Opens and interprets the modem
    commands file. */
    {
        FILE *in;
        char rec[MAXLINE + 1];
        char *s = rec;
        int token = -1, code = 1;
        keywords[1] = "DELAY";
        keywords[2] = "SEND";
        keywords[3] = "WAITFOR";
        keywords[4] = "TIMER";
        keywords[5] = "PORT";
        len[1] = 5;
        len[2] = 4;
        len[3] = 7;
        len[4] = 5;
        len[5] = 4;
        if ((in = fopen("commands", "r")) == 0)
            return (-1);
        while ((fgets(s, MAXLINE, in)) > 0)
        {
            if (debug)
                report("%s", s);
            if ((token = parse(s, token)) > 0)
                if ((code = doIt(s, token)) < 0)
                    return(code);
        }
        fclose(in);
        return(1);
    }

    main()
    {
        int i;
        printf("Driving Modem\n");
        switch(dialNum())
        {
            case -1:
                printf("Modem Commands \
file not found\n");
                exit(1);
                break;
            case -2:
                printf("\nModem Buffer \
Contains %s\n", buf);
                printf("Modem Timeout occurred\n");
                exit(1);
                break;
            case -3:
                printf("Open failed, \
error number %d\n", errno);
                perror("and the reason was ", errno);
                exit(1);
                break;
            default:
                printf("Connected\n");
                break;
        }
        waitSecs(3); /* Wait for it */
        i = readModem(bp); /* Clear the buffer */
        while (i > 0)
        {
            i = readModem(bp);
            bp = 0; /* Re-set the buffer pointer */
            /* *****
            You code goes here!
            ***** */
            printf("Disconnecting the modem\n");
            waitSecs(3); /* Hang about */
            disconnect(); /* modem to command mode */
            close(fd); /* Drop DTR, if HUPCL set */
            resetMode(); /* Re-set the port */
            exit(0);
        }
    }
}

```

Figure 5 - An application using the general terminal interface (Continued)

A read will not be satisfied until at least VMIN characters have been received or the timeout value VTIME has expired.

The code

The code in Figure 5 opens a script file called 'commands' and interprets the contents. If a line does not contain one of the key words DELAY, SEND, WAITFOR, TIMER or PORT, it is assumed to be a comment. The program is not case sensitive and I have only written the key words here in CAPITALS so that they STAND OUT a bit. Only one key word per line is processed. Arguments are enclosed in brackets and quotes, for instance DELAY ("1").

Predictably, the key word DELAY ("1") causes the program to wait for one second,

SEND ("at z") sends the Hayes reset string 'atz' to the modem followed by a carriage return character, WAITFOR ("OK") causes the program to wait until it sees the response 'OK' from the modem. WAITFOR will wait indefinitely unless a time out value in seconds has been set using TIMER.

The key word PORT has a special purpose and must be the first non-comment line. It causes the program to attempt to open a specified device file. The device file name must contain the full path and file name, for instance PORT ("/dev/tty2a") will open XENIX device file tty2a which addresses serial port COM2 on a PC.

Using these simple commands it is possible to construct script files that will initialise, dial and perform automated logon sequences

with any async modem. Having connected, I leave it as an exercise to the reader to write a simple terminal emulator or anything else that takes his fancy. The modem among you will notice that I haven't used function prototypes; this is because my XENIX compiler doesn't support them. Good Luck!

EXE

Richard Samworth is buying a new house and any extra money comes in handy. He is not available on any bulletin board but can be contacted by telephone on 0296 681 972.

The information in this article was based experiences with SCO XENIX System V Release 2.3 and AT&T UNIX System V/386 Release 3.2.

Cattullus - lingua novum serio

*Jules has been looking at computer languages again.
He thinks there are some lessons to be learned from history.*

Has it ever occurred to you how ugly computerspeak is? The New York accent may sound like traffic, and the Birmingham accent may sound like metalworking, but when two programmers or computer engineers get together the noise is enough to wilt flowers.

It wasn't always so bad. In the early days of computers we used real words, and where an acronym had to be used it was, at least, pronounceable. Now we seem to rely almost entirely on TLAs (three-letter acronyms), which only mean anything when written down. A conversation between two programmers is alphabet soup.

Apart from the fact that it is ugly, it causes real problems for non-English speakers. How is a Frenchman or a German supposed to figure out what 'PSP' or 'LDT' means? This whole issue of language compatibility is poised to become much more significant when the single market actually happens. There is a rule that every product sold in the EC must be marked in the language of the country in which it is sold. In French, PSP will become 'PSL' (*Prefixe du Segment du Logiciel*), and in German it will probably be only a single letter, 'P' (*Programsegmentpräfix*)!

There will be a problem, though, with software products. Not with the manuals, or the user-interfaces; translating these can be done very simply. The problem comes with source codes which must be moved across national boundaries, or programs written in macro languages which are bundled with the product. It will be practically impossible for a programmer

to look at a program written by a foreigner. The variable and procedure names will be chosen from the author's language. If he drops vowels the way British and American programmers do, it will be practically impossible to decode the names again (unless of course the programmer is Polish; he probably wouldn't bother with vowels in the first place).

Perhaps surprisingly, this is far from a new problem. Long before the EC was even a twinkle in a bureaucrat's eye, there was a problem with sharing knowledge and research among the intelligentsia of Europe. They used a language which was already functioning well across national boundaries, and was used almost exclusively for specialist knowledge. That language was Latin.

The version of Latin used during the Dark Ages was quite different from the Latin with which General Agricola boasted of his conquests. Roman Latin was a living language, full of idioms, irregularities, and conventions. Medieval Latin was a much simpler language, with almost no irregularities, but instead a large set of tenses and cases. The meaning of a sentence in medieval Latin was almost independent of the order of the words, so it was far more able to represent real thought processes than national languages were, but because of its orthogonality it was immediately comprehensible to anyone who knew even a little.

It was this combination of startling expressiveness and very orthogonal grammar that made it the language of choice

among the learned for over 1300 years. That most European languages were themselves based on corruptions of Roman Latin made the initial work of learning the language very much easier than it would otherwise have been.

***How is a
Frenchman or a
German supposed
to figure out what
'PSP' or 'LDT'
means?***

Neither was it a slow-moving language. When mathematics from the middle east and chemistry from the far east swept away mathesis and alchemy, Latin was the language in which they did it. Latin was sufficiently expressive to absorb these vast paradigm shifts without any significant changes to the language, and it is probably due to the fact that Latin was functioning so well that the new techniques and theories were propagated so fast.

I think the solution to the language problems in the EC are staring us in the face. If the whole of Israel was able to start conducting its daily life in Hebrew, I can't see why a few Euro MPs in Brussels

shouldn't be forced to learn Latin. I also think we should standardise programming terms to be in Latin. This shouldn't be hard at all - programming languages themselves are very artificial things with a very restricted grammar; applying similar conventions to user-defined names should involve no hardship, and if done consistently will improve readability across the new single market.

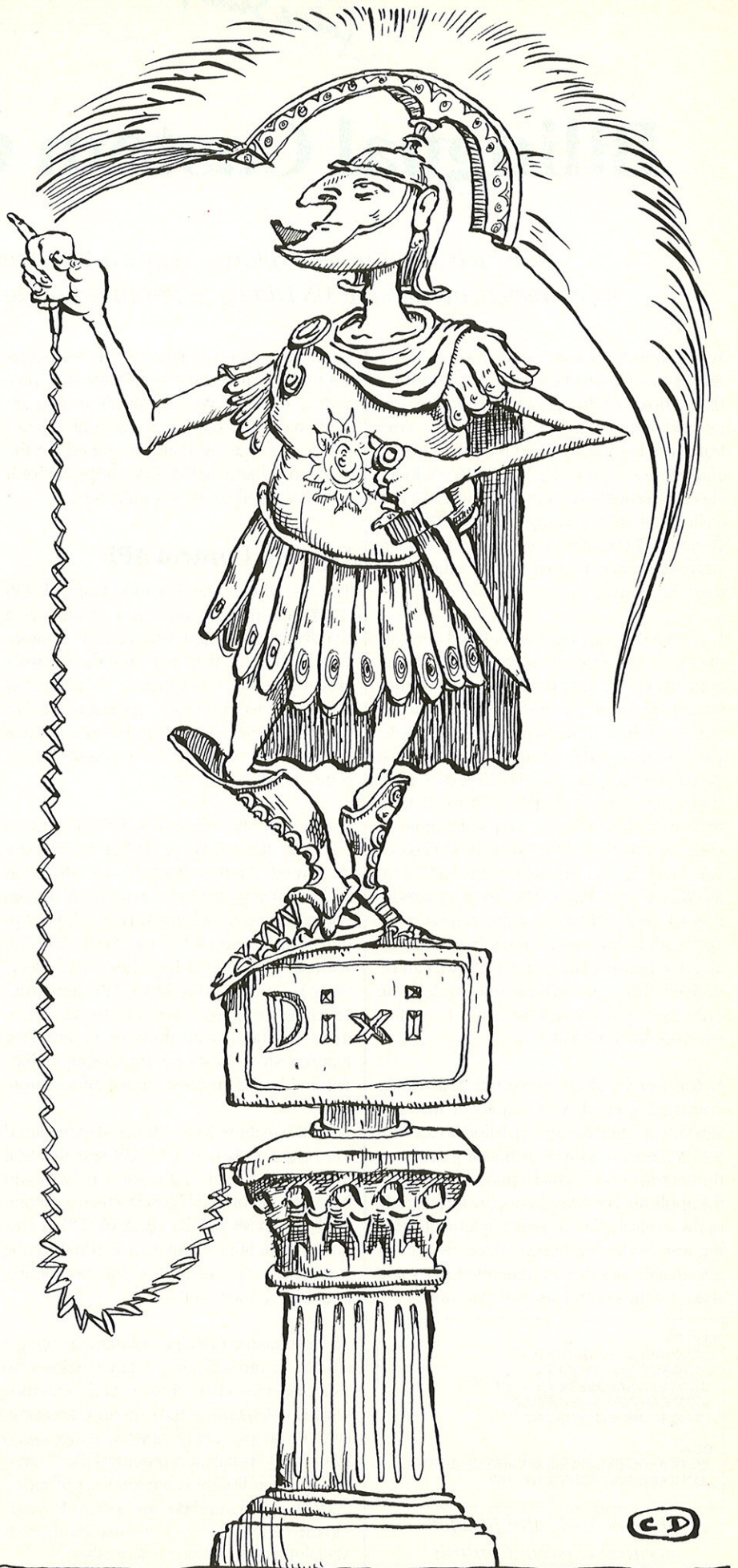
But why limit ourselves just to user-defined names? Almost all synthetic languages in common use limit themselves to nouns and imperative verbs. By using Latin as the basis of a programming language, one could introduce a procedure using an infinitive, apply it with an indicative, iterate with it using an imperative, terminate the iteration using a subjunctive, and so on. We could write complicated loops and conditionals in exactly the form we are thinking about them, instead of having to cast them into the limited forms that present compilers understand. An entire language could be created based on Latin grammar, a sort of cross between Prolog and Frames but without the parentheses. It would be admirably suited to representing knowledge, but would be capable of more than just the inference from facts that present AI languages can do - it could apply explicitly sequenced procedures as well. Such a language would also be an excellent intermediate language for machine translation between national languages.

What sort of control structures would such a language have? Again, we can refer to Latin literature and structure our programs as if they were plays. We would have an introduction, with a few minor players tidying the set, ready for the action. We could have minor gods and nobles performing the main action, with a chorus sweeping up after them and clarifying their actions to the audience, and finally a judgement from the major gods could perform the file loading and saving. Since the chorus is always present, the language would have multithreading built-in.

It might work. I think I'll call it 'Cattullus'.

EXE

Iulius libellendum est, qui linguae naturalis artificiosusque amat. facit-verbum suus per verbos Latinae furiabat. utervis per τελεφον Verulamium CCI-VEEMMMCLXXXV vel per CIX ad jules colloquerat.



Bilingual Custom Controls

In which our humble explorer creates a Windows Custom Control recognisable by both the MS Dialog Editor and Borland Resource Workshop...

We all know what a 'Control' is (?) That's one of those gadgets we put in a Windows dialog box to either get input from the user or send output to the user. Edit boxes, radio buttons, check boxes and list boxes are all examples of controls. Windows includes several predefined controls which you can easily drop into a dialog using MS DlgEdit, Borland's Resource Workshop, the White-water Resource Toolkit, or any other 'Dialog Editor' program.

But what if none of the predefined controls fit your criteria? Of course you can write the code necessary to implement a new control (which is, after all, just another kind of window). If you are writing in straight C, your work is a bit difficult, as you must define and register a new Windows class (not to be confused with C++ classes!), then write a `WndProc()` which will handle all messages to be sent to your new class of windows. If you are using Borland's ObjectWindows (OWL), Microsoft's Foundation Classes (MFC), or some similar OOP application framework, the job is easier, as a new window class (the C++ type) can be derived from an existing one, redefining only those behaviours that must be different from the base class.

Unfortunately, after you've finished writing your new control, you'll discover that you can't use it when designing dialog boxes with a dialog editor. As well as needing access to the control's code (which is inconveniently in the application's .EXE) to display an example of the control and properly implement a dialog test mode, the dialog editor also needs information about recommended sizes and styles for the control, as well as a function to

input style data unique to this particular control. Because the control's window procedure exists in your application, you are stuck haplessly coding in the control's position and size by hand, followed by the incessant chatter of the disk's stepper motor as you compile, test, compile, test,...

Custom Control API

This is where the Custom Control API (CCAPI) comes to the rescue. It defines a standard for writing Dynamic Link Libraries (DLL) which contain not only the control's class registration and window procedure, but also a few procedures which the dialog editor uses to integrate creation and modification of custom controls with the manipulation of Windows standard controls.

In spite of the extreme utility of custom controls, the CCAPI is rather poorly documented. Neither Borland nor Microsoft include any printed material about custom controls (I was looking at BC++ 3.0 & Application Frameworks, and MS C/C++ 7.0 without SDK manuals). Therefore, everything I learned about the CCAPI came from example programs and electronic documents included with these two compilers. Figure 1 shows a short bibliography of files where I found custom control information.

To make matters worse, Borland considered the original Microsoft CCAPI specification inadequate (true) so it made a new CCAPI based on the original (good) which is incompatible with Microsoft's (BAAAAAD!). A custom control library written according to one publisher's specifications will be incompatible with the other's tools.

To illustrate the principals of implementing a custom control library, I have written an example custom control called 'Thermo', which implements a simple thermometer similar to those 'percent completed' gauges seen in so many installation programs these days. The Thermo library is written to conform to both Microsoft's and Borland's CCAPIs. Thermo can be installed into, and used with, both MS DlgEdit and Resource Workshop.

An Application's View

As far as an application is concerned, a custom control looks just like any standard control. They can be created either with a `CONTROL` statement in a dialog script, or by using the control's registration class ('Thermo' in our example) in a call to `CreateWindow()`. The only difference is that, before it can use one of the controls, the app must load the custom control library into memory using `LoadLibrary()` from the Windows API:

```
HANDLE hClib =
    LoadLibrary("THERMO.DLL");
```

This should usually be done at the beginning of `WinMain()` or during processing of the `WM_NCCREATE` message in the app's main window. It is good practice to check the value in `hClib`. If it is less than 32, there was an error and the DLL was not loaded.

When a DLL is loaded into memory, its `LibMain()` function is automatically called. A custom control's `LibMain()` should register the control's window class to make it available to applications. Notice that Thermo's Style bits include `CS_GLOBALCLASS`, making the class available to all apps in the system. When the application is finished using the control, it should release the DLL with the following statement:

```
FreeLibrary(hClib);
```

In the end, the only parts of the DLL used by an application are the `LibMain()` (to register the class) and the `WndProc()` (to process messages sent to controls of the class). Thermo's `LibMain()` and `ThermoWndProc()` are shown in Figure 2.

Thermo's Internals

A Thermo keeps information about itself, including its range, current temperature, and the colours to use when painting, in a `THERMO` struct stored on the local heap. A handle to a separate `THERMO` for each instance is saved in the first word of the 'extrabytes' of the Thermo's window structure. A window's `THERMO` is allocated during the `WM_CREATE` message, and

```
MSC7.0
\700\INCLUDE\CUSTCNTRL.H
\700\MFC\DOC\TN014.TXT
\700\MFC\SAMPLES\CTRLTEST.*
\700\SAMPLES\MUSCROLL.*
\700\SAMPLES\RAINBOW.*
```

```
BC++
\BORLAND\EXAMPLES\WORKSHOP\BITBTN.*
\BORLAND\DOC\CUSTCNTRL.RW
```

Figure 1 - Useful files for writing Custom Controls

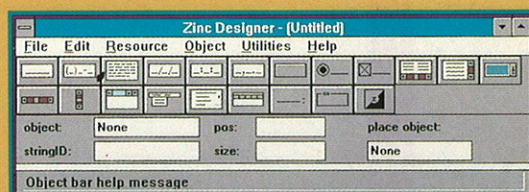
(ZINC)

BEFORE YOU

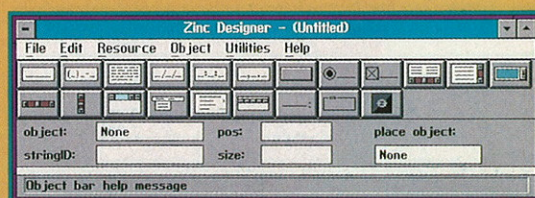
LINK

THINK ABOUT IT.

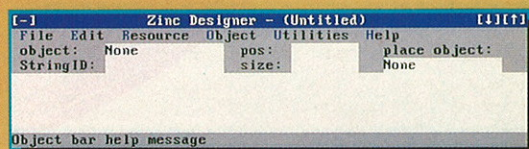
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[MS WINDOWS]



[DOS GRAPHICS]



[DOS TEXT]

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			TURBO VISION	OBJECT WINDOWS
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DOS GRAPHICS	■			
DOS TEXT	■		■	
SINGLE-SOURCE SUPPORT FOR WINDOWS 3.X, DOS GRAPHICS AND DOS TEXT	■			
FULL ACCESS TO WINDOWS API	■	■		■
MULTIPLE COMPILER SUPPORT (ZINC SUPPORTS BORLAND, MICROSOFT AND ZORTECH C++ IN ONE BOX)	■			
INTEGRATED DESIGN TOOL	■	□		□
WINDOWS (PARENT, CHILD, MDI), MENUS (PULL-DOWN, POP-UP, HIERARCHICAL), BUTTONS (REGULAR, BITMAP, RADIO BUTTON, CHECK BOX), GROUP BOXES, COMBO BOXES, HORIZONTAL AND VERTICAL SCROLL BARS, VERTICAL SCROLLING LISTS, STRING INPUT FIELDS	■	■	■	■
DATE, TIME, NUMBER AND FORMATTED STRING INPUT FIELDS, HORIZONTAL SCROLLING LIST BOXES, TOOL BARS	■			
LIST BOXES, COMBO BOXES AND TOOL BARS THAT CONTAIN ICONS, BUTTONS, RADIO BUTTONS, CHECK BOXES AND INPUT FIELDS (E.G. STRING, DATE, TIME)	■			
BUILT IN DATA VALIDATION	■			
NO EXTENSIONS TO C++ LANGUAGE REQUIRED	■	■	■	

□ RESOURCE TOOLS ARE INCLUDED, BUT DO NOT PROVIDE DIRECT INTEGRATION OF USER PROCEDURES AND VALIDATION ROUTINES OR DIRECT ACCESS TO LIBRARY OPTIONS.

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released during WM_DESTROY. In the example code, I set the fields of the THERMO to default values in WM_CREATE, but with a bit more work, you can parse these values from the control's 'text', which can be found in the CREATESTRUCT pointed to with the message's lParam:

```
((LPCREATESTRUCT) lParam)->
    lpzName
```

Although small bits of window-specific information can be stored directly in a window's extrabytes, larger data structures are easier to access if kept in a separate place,

storing a handle to that place in the extrabytes. Neophyte Windows programmers should note that the size of a window's extrabytes is determined by the cbWndExtra field of the window's WNDCLASS struct, and these bytes are read and written with the Windows API GetWindowWord() and SetWindowWord() functions.

Painting a Thermo

A Thermo's display is quite simple - finding the ratio of Temp / (High - Low), it

accordingly paints part of its rectangle in the background colour and part in the foreground colour. Displaying this numerically and putting a border around the edges would be nice, but take up extra room in our limited space. Likewise, no check is made to eliminate redundant repaints - if anything changes, the entire Thermo is repainted. Prudent use of InvalidateRect() and GetUpdateRect() could make paints much more efficient.

An important side note here is the processing of WM_ERASEBKGD. We effectively swallow this message, ensuring that the control doesn't flicker while being repainted.

Controlling a Thermo

ThermoWndProc() accepts several commands which affect a Thermo's display. For example, the THM_SETTEMP message will set Temp to the value given in the message's wParam. Since a Thermo will usually be in a dialog box, these messages are best sent via SendDlgItemMessage():

```
SendDlgItemMessage(hDlg, 102,
    THM_SETTEMP, 25, 0);
```

will set the Temp of the Thermo in dialog hDlg with control ID 102 to 25. Other messages work similarly.

To test Thermo, I added the WM_LBUTTONDOWN and WM_RBUTTONDOWN messages. These just generate a THM_RAISE or THM_LOWER message so that, by pressing the left or right mouse button repeatedly, you can watch the thermometer go up and down. You should remove these messages before putting Thermo to real use.

Interface to MS

For MS DlgEdit compatibility, a custom control DLL must have three special functions whose names aren't important, but which must be exported with certain ordinal values. For Thermo, these functions have the names CtlInfo(), CtlStyleDlg(), and XlateCtlFlags(), and they are exported with ordinals 2, 3 and 4 respectively. The necessary .DEF file can be seen in Figure 3, while the functions themselves are in Figure 4.

CtlInfo @2

CtlInfo() assembles and returns a CTINFO structure, which contains information about the class's registration name, version and title, as well as an array of CTLTYPES, which are just predefined styles of the same class. The struct defini-

```
// thermo.c - Thermo Custom Control
// Laine Stump, Sept 9, 1992
// RightToCopy (r) 1992
//
#include <windows.h>
#include <custcntl.h> // MS Custom Control
#include "rwcust.h" // Borland
Extensions
#include "thermo.h"
#include "thermdlg.h"
typedef struct
{ // info stored for each Thermo
    int Low, High, Temp;
    LONG FColor, BColor;
} THERMO;
typedef THERMO * PTHERMO;
char ThName[] = "Thermo";
char ThVDescr[] = "Vert Thermo";
char ThHDescr[] = "Horiz Thermo";
char ThVStyle[] = "THS_VERTICAL";
char ThHStyle[] = "THS_HORIZONTAL";
static HANDLE hInstance;
/*****
void InvalidateAll(HWND hWnd)
{ // invalidate entire client area
    RECT r;
    GetClientRect(hWnd, &r);
    InvalidateRect(hWnd, &r, 0);
} // InvalidateAll()
*****/
// ThermoWndProc() - processes messages
// sent to a Thermo
LONG FAR PASCAL ThermoWndProc(HWND hWnd,
    WORD wMessage, WORD wParam, LONG lParam)
{
    DWORD result = 0;
    PTHERMO thd
        = (PTHERMO) GetWindowWord(hWnd, 0);
    switch( wMessage )
    {
        case WM_CREATE:
            // allocate & init data area
            thd = (PTHERMO) LocalAlloc(LPTR,
                sizeof(THERMO));
            SetWindowWord(hWnd, 0, (HANDLE) thd);
            // set some values - should read
            // from control's title instead
            thd->Low = 0;
            thd->High = 100;
            thd->Temp = 0;
            thd->FColor = 0x0000FF; //red
            thd->BColor = 0; //black
            break;
        case WM_DESTROY:
            // free data area
            LocalFree((HANDLE) thd);
            break;
        case WM_PAINT:
            { //very inefficient paint
                double percent;
                PAINTSTRUCT ps;
                RECT ff, bf;
                HBRUSH fb, bb;
                BeginPaint(hWnd, &ps);
                // find size of client area
                GetClientRect(hWnd, &ff);
                ff.right++; ff.bottom++;
                bf = ff;
                // determine how much of each
                percent
                    = (1.0 * (thd->Temp - thd->Low))
                      / (thd->High - thd->Low);
                if (GetWindowLong(hWnd, GWL_STYLE)
                    & THS_VERTICAL)
                { // vertical split
                    ff.top = bf.bottom
                        = ff.bottom
                          - (WORD) (ff.bottom * percent);
                }
                else
                { // horizontal
                    ff.right = bf.left

```

Figure 2 - THERMO.C, LibMain() and ThermoWndProc()

tions for CTLINFO and CTLTYPE can be found in Windows' CUSTCNTRL.H file. Unfortunately, CTLINFO only allows for a single class, so MS compatible DLLs can only have one class. You can, however, have different styles of the same class. For example, Thermo has a horizontal and a vertical style. With small differences in the data, the CtlInfo() function is identical for all custom control DLLs.

CtlStyleDlg @3

CtlStyleDlg() brings up a dialog box which allows changing style and other information for an instance of the control. DlgEdit calls this function when you double click on a control after placing it in a dialog. When calling, it sends a handle to a CTLSTYLE struct (also in CUSTCNTRL.H) containing current information for the control.

ThStyleDlgProc() is used to process messages between the controls in the style dialog. Currently, Thermo's style dialog only allows changing the ID number and title of the control, although all aspects of the control, including size, position, and style flags, are accessible through the CTLSTYLE. The definition of the dialog used is in Figure 5.

The lpfnIdToStr and lpfnStrToId parameters are pointers to functions provided by DlgEdit which convert the ID number between binary and string form. If a .H file has been loaded into DlgEdit, these functions will recognise, and attempt to use, the IDs defined in the .H file. Strangely, lpfnStrToId returns the binary value in the top word of its long return value - the low word is non-zero if a valid conversion was made.

XlateCtlFlags @4

The last function, XlateCtlFlags(), is used to convert a control's style bits into a text string which goes in the CONTROL statement. Since Thermo only uses two mutually exclusive styles, this function is rather simple, returning either the string

```

LIBRARY  THERMO
DESCRIPTION 'A thermometer control'
EXETYPE  WINDOWS
CODE     MOVEABLE DISCARDABLE PRELOAD
DATA     PRELOAD MOVEABLE SINGLE
HEAPSIZE 4096
EXPORTS
; required for MS DLGEDIT
CtlInfo      @2 ;Do Not Change
CtlStyleDlg  @3 ;Do Not Change
XlateCtlFlags @4 ;Do Not Change
;required for Resource Workshop
ListClasses  @5
RWctlInfo    @6
; general
TermoWndProc @7
ThStyleDlgProc @8

```

Figure 3 - THERMO.DEF

```

/*****
// MS Dialog Editor interface functions
// (part of THERMO.C)
*****/
void SetCtlInfo(LPCTLINFO CI,
WORD Version, WORD CtlTypes,
LPSTR Class, LPSTR Title)
{ // Set the fields of a CTLINFO
CI->wVersion = Version;
CI->wCtlTypes = CtlTypes;
lstrcpy(CI->szClass, Class);
lstrcpy(CI->szTitle, Title);
} // SetCtlInfo()

void SetCtlType(CTLTYPE FAR *CT,
WORD Type, WORD Width, WORD Height,
DWORD Style, LPSTR Descr)
{ // set the fields of a CTLTYPE
CT->wType = Type;
CT->wWidth = Width;
CT->wHeight = Height;
CT->dwStyle = Style;
lstrcpy(CT->szDescr, Descr);
} // SetCtlType()

/*****
// CtlInfo() - create & return a handle
// to info structure
HANDLE FAR PASCAL CtlInfo(void)
{
LPCTLINFO pCI;
HANDLE hCI;
//Allocate an INFO struct
hCI=GlobalAlloc(GMEM_MOVEABLE,
sizeof(CTLINFO));
if (hCI==NULL) return NULL;
// get a pointer to it
pCI=(LPCTLINFO)GlobalLock(hCI);
if (pCI==NULL)
{
GlobalFree(hCI);
return NULL;
}

// init data items
SetCtlInfo(pCI, 0x100, 2, ThName,
ThName);
SetCtlType(&pCI->Type[0], 0, 20, 60,
WS_CHILD | WS_VISIBLE | THS_VERTICAL,
ThVDescr);
SetCtlType(&pCI->Type[1], 0, 60, 20,
WS_CHILD | WS_VISIBLE | THS_HORIZONTAL,
ThHDescr);
// send handle to info to DLGEDIT
GlobalUnlock(hCI);
return hCI;
} // CtlInfo()

/*****
WORD FAR PASCAL XlateCtlFlags(
DWORD Flags, LPSTR Style, WORD MaxLen)
{ // convert binary flags to string
if (Flags & THS_HORIZONTAL)
lstrcpy(Style, ThHStyle);
else
lstrcpy(Style, ThVStyle);
// other styles (hopefully) handled
// by Dialog Editor
return lstrlen(Style);
} // XlateCtlFlags()

/*****
// Dialog Box to modify control style
//
// statics to remember between messages
static HANDLE hCtlStyle;
static LPFNSTRTOID StrToId;
static LPFNIDTOSTR IdToStr;

```

```

LONG FAR PASCAL ThStyleDlgProc(HWND hDlg,
WORD wMessage, WORD wParam, LONG lParam)
{ // style dialog window procedure
LPCTLSTYLE lpCtlStyle;
char Temp[32];
switch (wMessage)
{
case WM_INITDIALOG:
lpCtlStyle
= (LPCTLSTYLE)Global-
Lock(hCtlStyle);
if (lpCtlStyle==NULL) return FALSE;
// convert ID to string for editing
(*IdToStr)(lpCtlStyle->wId,
(LPSTR)Temp, 32);
SetDlgItemText(hDlg, ID_IDEDIT,
Temp);
SetDlgItemText(hDlg, ID_TITLEEDIT,
lpCtlStyle->szTitle);
GlobalUnlock(hCtlStyle);
break;
case WM_COMMAND:
switch (wParam)
{
case IDOK:
// convert ID back to binary
lpCtlStyle = (LPCTLSTYLE)
GlobalLock(hCtlStyle);
GetDlgItemText(hDlg, ID_IDEDIT,
Temp, 32);
lpCtlStyle->wId = HIWORD(
(*StrToId)(LPSTR)Temp));
SetDlgItemText(hDlg, ID_TIT-
LEEDIT,
lpCtlStyle->szTitle,
CTLTITLE);
GlobalUnlock(hCtlStyle);
EndDialog(hDlg, TRUE);
break;
case IDCANCEL:
EndDialog(hDlg, FALSE);
break;
}
break;
default:
return FALSE;
}
return TRUE;
} // ThStyleDlgProc()

/*****
BOOL FAR PASCAL CtlStyleDlg(HWND hWnd,
HANDLE hCtlStyle,
LPFNSTRTOID lpfnStrToId,
LPFNIDTOSTR lpfnIdToStr)
{ // display a dialog box to change
// control styles
FARPROC StyleDlgProc;
BOOL result;
//Save vital info for the dialog.
hCtlStyle = hCtlStyle;
StrToId=lpfnStrToId;
IdToStr=lpfnIdToStr;
//Show dialog box
StyleDlgProc
= MakeProcInstance(
(FARPROC)ThStyleDlgProc,
hInstance);
result=DialogBox(hInstance,
MAKEINTRESOURCE(IDD_STYLEDIALOG),
hWnd, StyleDlgProc);
FreeProcInstance(StyleDlgProc);
return result;
} // CtlStyleDlg()
/*****

```

Figure 4 - THERMO.C, MS DlgEdit Interface functions

'THS_VERTICAL' or 'THS_HORIZONTAL'. Control classes with more styles would require more elaborate functions, creating a string of several constants separated with '|'.

Interface to Borland

Probably prompted by the design of the Borland Windows Custom Control (BWCC) library (which contains several classes in a single DLL), programmers at Borland decided that Microsoft's CCAPI was inadequate. They produced their own CCAPI for Resource Workshop which, although they say it is an 'extension' of Microsoft's version, is not an exact superset.

To work with Resource Workshop, a custom control DLL must export a function with the name ListClasses() (ordinal number is unimportant). ListClasses() returns a structure containing an array with pointers to the three previously mentioned functions for each control class in the DLL. While the CtlStyleDlg() and XlateCtlFlags() functions given here are the same functions used in the MS CCAPI, CtlInfo() must change slightly (See Figure 6).

RWctlInfoO

Borland added two new members to CTLTYPE, naming the resulting struct

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RWCTLTYPE (contained Borland's version of CUSTCNL.H, or in RWCUST.H [available on disk] if you're using MSC++). The first of the new members is hToolBit, which is a handle to a 24x24 bitmap which will be placed as a button on Resource Workshop's toolbar. Clicking the new button will 'load' the cursor with the given control. If hToolBit is NULL, no button will be added, and you will only be able to access your custom control through the dialog produced by the 'Control', 'Custom...'.

The other new member is hDropCurs, a handle to a cursor. If non-NULL, the cursor will be changed to this shape when it is loaded with the given control. If NULL, a standard cross-hair cursor will be used.

Accommodating Both

As long as you can live with having only a single control per DLL, you can make your custom control compatible with both DlgEdit and Resource Workshop. Although the Microsoft and Borland methods each need different CtlInfo() functions, the functions are found in different ways - one via its ordinal in the exports, one via a pointer returned from ListClasses(). Just write two functions, each with a different name, as I have done for Thermo, and use them in their rightful places.

Compiling

I compiled Thermo using Microsoft C/C++ 7.0. With its Programmer's Workbench, I selected a 'Windows 3.1 DLL' project template, then added the files THERMO.C, THERMO.RC, and THERMO.DEF. At first, the DLL wouldn't register properly in DlgEdit. I noticed that the options for function entry code were set for -GD (protected mode DLL entry code), while those in an example program were set to -Gw (real mode DLL entry code). After changing the PWB Global options entry code selection to 'None' (to remove the -GD) and adding -Gw

```

/*****
// Extra functions for Resource Workshop
// compatibility.
//
void SetRWctlType(LPRWCTLTYPE CT,
WORD Type, WORD Width, WORD Height,
DWORD Style, LPSTR Descr,
WORD ToolID, WORD CursID)
{ // set the fields of a RWCTLTYPE
CT->wType = Type;
CT->wWidth = Width;
CT->wHeight = Height;
CT->dwStyle = Style;
lstrcpy(CT->szDescr, Descr);
if (ToolID)
CT->hToolBit = LoadBitmap(hInstance,
MAKEINTRESOURCE(ToolID));
else
CT->hToolBit = NULL;
if (CursID)
CT->hDropCurs = LoadCursor(hInstance,
MAKEINTRESOURCE(CursID));
else
CT->hDropCurs = NULL;
} // SetCtlType()
/*****
// RWctlInfo() - create & return a handle
// to info structure (for Res. WkShop)
HANDLE FAR PASCAL RWctlInfo(void)
{
LPRWCTLINFO pCI;
HANDLE hCI;
//Allocate an INFO struct
hCI=GlobalAlloc(GMEM_MOVEABLE,
sizeof(RWCTLINFO));
if (hCI==NULL) return NULL;
// get a pointer to it
pCI=(LPRWCTLINFO)GlobalLock(hCI);
if (pCI==NULL)
{
GlobalFree(hCI);
return NULL;
}
}

```

```

// init data items
SetCtlInfo((LPCTLINFO)pCI, 0x100,
2, ThName, ThName);
SetRWctlType(&(pCI->Type[0]), 0, 20, 60,
WS_CHILD | WS_VISIBLE | THS_VERTICAL,
ThVDescr, ID_VERTBIT, NULL);
SetRWctlType(&(pCI->Type[1]), 0, 60, 20,
WS_CHILD | WS_VISIBLE | THS_HORIZON-
TAL,
ThHDescr, ID_HORBIT, NULL);
// send handle to info to Res. WkShop
GlobalUnlock(hCI);
return hCI;
} // RWctlInfo()
/*****
// Do not change this function's name!!
HANDLE FAR PASCAL ListClasses(
LPSTR szAppName, WORD wVersion,
LPFNLOADRES fnLoad, LPFNEDITRES fnEdit)
{ // construct a list of all classes
// in this DLL
HANDLE hClasses
= GlobalAlloc(GMEM_SHARE | GMEM_ZE-
ROINIT,
sizeof(int) + sizeof(RWCTLCLASS));
if (hClasses)
{
LPCTLCLASSLIST Cl = (LPCTLCLASSLIST)
GlobalLock(hClasses);
Cl->nClasses = 1;
Cl->Classes[0].fnRWInfo = RWctlInfo;
Cl->Classes[0].fnRWStyle = CtlSty-
leDlg;
Cl->Classes[0].fnFlags = XlateC-
tlFlags;
lstrcpy(Cl->Classes[0].szClass,
ThName);
GlobalUnlock(hClasses);
}
return hClasses;
} // ListClasses()
/***** end of thermo.c *****/

```

Figure 6 - THERMO.C, Resource Workshop Interface extensions

to the list of 'other options', I recompiled and everything worked fine. Being late as usual, I didn't have time to investigate exactly why the protected mode version of entry/exit code didn't work properly.

By building a project for a Small model Windows DLL, removing the reference to RWCUST.H, and erasing the (WNDPROC) typedef, this program will also compile with Borland C++. Be sure you set the option to use the C++ compiler only for .CPP files, otherwise the export names will be generated incorrectly.

Summary

To create a custom control DLL usable by both MS DlgEdit and Resource Workshop,:

- Write a LibMain() which registers the class, and a WndProc() to process the control's messages.
- Write CtlInfo(), CtlStyleDlg(), and XlateCtlFlags() functions and list them in the exports as ordinal 2, 3, and 4.
- Write a RWctlInfo() function similar to CtlInfo(), but using the RWCTLTYPE and RWCTLINFO structures, and ListClasses() function which gives the addresses of RWctlInfo(), CtlDlgStyle() and XlateCtlFlags(). Export ListClasses() with any ordinal you like, but don't change its name.

EXE

```

// THERMO.H ****
// messages
#define THM_SETRANGE (WM_USER+1)
#define THM_GETRANGE (WM_USER+2)
#define THM_SETTEMP (WM_USER+3)
#define THM_GETTEMP (WM_USER+4)
#define THM_RAISE (WM_USER+5)
#define THM_LOWER (WM_USER+6)
// styles
#define THS_VERTICAL 1
#define THS_HORIZONTAL 2
// THERMODLG.H ****
// dialog box IDs
#define IDD_STYLEDIALOG 50
#define ID_HORBIT 51
#define ID_VERTBIT 52
// dialog item IDs
#define ID_IDEDIT 100
#define ID_TITLEEDIT 101
// THERMO.RC ****
#include <windows.h>
#include "thermo.h"
#include "thermdlg.h"

```

```

#include thermdlg.dlg
ID_HORBIT BITMAP thermhor.bmp
ID_VERTBIT BITMAP thermvrt.bmp
// THERMODLG.DLG ****
IDD_STYLEDIALOG DIALOG 52, 61, 153, 73
STYLE DS_MODALFRAME | WS_POPUP |
WS_VISIBLE
| WS_CAPTION | WS_SYS-
MENU
CAPTION "Thermo Style Information"
FONT 8, "MS Sans Serif"
BEGIN
RTEXT "Text:", -1, 3, 10, 19, 8
EDITTEXT ID_TITLEEDIT, 23, 9, 122,
12, ES_AUTOHSCROLL
RTEXT "ID:", -1, 2, 30, 20, 8
EDITTEXT ID_IDEDIT, 23, 29, 63,
12, ES_AUTOHSCROLL
DEFPUSHBUTTON "OK", IDOK, 20, 50, 40, 18
PUSHBUTTON "Cancel", IDCANCEL,
92, 50, 40, 18
END

```

Figure 5 - Misc Support files for Thermo project

The full source to an 'improved version' (promises Laine) of the code can be obtained by sending in a disk as per the rules laid out on Page 3, column 1. Please mark your envelopes 'CONTROL'.

Laine Stump is a C++ programmer who believes that, if C columnists can write about C++, he can damn well write about C.

Laine now has an email address: laine@trbilun.bitnet. He can also be contacted by fax at 010 90 4 418 5779, or post at Bilkent University, Lojmanlar 3/9, 06533 Bilkent / Ankara, TURKEY.

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QBE for Clipper

Guy Smith releases the power of Clipper's OO to create a useful descendant of TBrowse.

By now, the inclusion of a fixed class system in Clipper 5.01 will be apparent to most users. In recent months, several articles have already introduced third party additions such as SuperClass and Class(y) which offer class creation facilities similar to those coming in the next release of Clipper. This article details a Query By Example class for Clipper 5.01 written using SuperClass.

The aim of this article is to provide a programmable/controllable Query By Example facility, to provide an example of a complex class (classic examples of classes such as queue, stack and list offer insufficient incentive for Clipper programmers to change their programming style), to provide a practical example of inheritance and encapsulation.

The problem is explained in three stages: from the viewpoint of the user, from the viewpoint of the programmer using the Query By Example class, and from the viewpoint of the programmer creating the Query By Example class.

QBE for the User

Query By Example (QBE) is an end-user tool for describing a set of records. Traditional methods for allowing the user to describe a set of records at run-time include manually typing an English-like expression, manually entering a SQL expression (or an expression in the host language eg Clipper) and building an expression piece by piece using an expression builder.

The first two can be dismissed as unnecessarily unfriendly. The third is generally thought to be friendly, but rapidly becomes cumbersome and confusing when used to build complex expressions involving boolean logic. Users find it awkward to express which relationships are ANDed, which are ORed and to what expression or expressions a NOT applies to.

QBE has been available in Paradox since its first release, and more recently appeared in dBase IV and FoxPro. QBE offers the user a matrix

within which to enter criteria. Each column of the matrix is typically headed by a field name. Thus to express the condition 'all customers located in Nottingham' the user moves the light bar to the row beneath the TOWN heading and types 'Nottingham'.

QBE is simple to use, but where it scores over more traditional techniques is that it carries on being simple to use even as the complexity of the expression increases. To express an AND condition (eg 'all customers located in Nottingham AND the last date of contact was before 1st January 1992') the user enters '< 01/01/92' in the LAST CONTACT column *on the same row*. To express an OR condition, subsequent conditions are placed on different rows. The user can clearly see which conditions are ANDed and which conditions are ORed by their placement on the screen.

Such a high-level feature is typically outside the scope of the Clipper language, and programmers are expected to build the feature themselves using Clipper primitives.

QBE for the Programmer

As we will be writing the QBE class, the scope, power and facilities of the QBE are directly under our control. Whereas Paradox and dBase IV programmers need make no effort to incorporate QBE facilities into their programs, one drawback is that they have minimal or no control over the result, and its extensibility is limited.

For the sake of brevity, the QBE designed here will be limited. It will be a flat file query (ie it will not be possible to create multi table queries). The demonstration code will not support adding calculated fields (though the class will support this).

The code in Figure 1 demonstrates a simple modal use of a QBE. It opens any file, creates a new QBE using QBENew() and initiates a loop that repeatedly calls QBEModal() (which returns control to the user to enter a query) and then lists the records which match that query.

At the highest level, therefore, the programmer needs to know how to create the query (QBENew()), how to let the user enter the query (QBEModal()) and how to write code which uses the query entered. From the code in Figure 1 you can see that the FOR condition of the LIST command contains 'eval(oQBE:exprBlock)'. The exprBlock instance variable of the QBE class always contains a code block which evaluates to a true or false depending on the query entered.

Beneath this superficial layer lies the code which directly manipulates the QBE object. For many programmers this layer would never be manipulated. For this next step, a knowledge of the QBE class is necessary.

QBE Class Explained

Obviously from the examples given earlier it can be seen that queries are entered into a matrix. The Clipper language supports two kinds of matrices: DBF files and multidimensional arrays. Of the two, the more flexible is multidimensional arrays. In addition, arrays are faster for small numbers of rows and can be encapsulated within an object.

A significant part of the query class will be the representation of the query on the screen. For this part, Clipper already provides a powerful and flexible class: TBrowse. So the query class will be remarkably similar to TBrowse, and can be inherited from it. In addition it will contain the data which is being browsed (ie the query

```
function Main()
local oQBE
set ScoreBoard off
* set offensive colour scheme ON
set color to W+/B, GR+/G,,,GR/G
use anyfile
oQBE:=QBENew()
do while .not. lastkey()==K_ESC
  QBEModal(oQBE)
  clear
  list fieldGet(1), fieldGet(2),:
    fieldGet(3) for eval(oQBE:exprBlock)
  inkey(0)
enddo
return(NIL)
```

Figure 1 -
Simple modal use of QBE Class

matrix) and also several additional methods and instance variables which allow manipulation and interrogation of the query. Figure 2 shows the QBE methods and instance variables, although I have deliberately omitted those inherited from TBrowse.

Like TBrowse the QBE class contains columns. Figure 3 shows the QBEColumn methods and instance variables with the exception of those inherited from TBColumn.

QBENewO

QBENew () is a function which takes the drudgery out of creating a new QBE object. It accepts an array of the structure to query and defaults this to the structure of the currently selected file. It creates a new query in the line

```
local oQBE:=
    qbe():new(4,1,11,78)
```

and adds oQBEColumn objects for each field defined in the structure array. Notice that the oQBEColumn:new () class constructor accepts three parameters. The first is the QBE object, the second is the column heading and the third the column expression (probably the field name). Thus the QBE class already scores over its contemporaries in being able to display the English names of fields (possibly loaded from a data dictionary) as opposed to ugly field names.

QBEModalO

QBEModal (), shown in Figure 4, is similar to Clipper's own ReadModal () in purpose; it assembles all the QBE features in an intelligent way. Note, however, that QBEModal () is deliberately left as a function which is under the control of the programmer and not as a method of the QBE class. There are two reasons for this. First, as its name implies, QBEModal () is modal and, therefore, places an unnecessary design constraint upon user of the class ie that the user interface is modal and cannot be event driven. Second, QBEModal () is simply one way of doing this job. In this respect, QBEModal () is directly analogous to the way Clipper's own BROWSE () function assembles the TBrowse class: it is useful, but does not exploit the class to its full potential and is not adaptable.

QBEModal () treats the QBE object just like a TBrowse object. QBEModal () paints the screen and initialises a loop which stabilises the query, accepts keystrokes, acts on predefined keystrokes using TBApplKey () (which saves the drudgery of writing out all the TBrowse methods and corresponding keystrokes) and detects an attempt to enter data into the query. When such an attempt is detected it calls QColGet ().

QColGet (), shown in Figure 5, can extract the relevant cell to be entered/edited from the query as it can find both the current row (oQBE:rowPointer) and the current column (oQBE:colpos). It offers this to the user at the current screen row and column and then attempts to assign it back to the column using oCol:assign (cEntry, oQBE:rowPointer). QBEColumn:assign () can reject the assignment if the cell has some logical inconsistency (eg the cell attempts to do division on a date field).

QBE for the class writer

As will be apparent by now, the majority of work is performed by TBrowse and TBColumn. All instance variables and methods are inherited and for the large part used 'as is'. However, the QBE class has a few additions and differences.

For example, the class constructor also ensures that the TBrowse:goTopBlock, TBrowse:goBottomBlock and TBrowse:skipBlock instance variables are set. As the data for query and the query row pointer are encapsulated within the query itself, it is a matter of simplicity to set them immediately.

The QBE class maintains a count of the number of rows in the query so that new columns can be added at any time (say, for adding calculated or related fields) and the new col-

Instance variables

qRowCount	The number of rows in the query
rowPointer	The current row in the query
ExprClip	A string of the query in Clipper code
ExprUser	A string of the query in English
ExprBlock	A code block of the query

Methods

Reset()	Clear down the query
Settle()	Settles the query after an assignment
AddRow()	Add a new row to all columns
DelRow(nRow)	Delete an existing row from all columns
ExprUserDisplay()	Display the English query in a box
ExprClipUpdate()	Update the ExprClip after a query change
ExprUserUpdate()	Update the ExprUser after a query change

Figure 2 - QBE Instance variables and methods

Instance variables

ExprClip	The Clipper string of this column (typically the fieldname)
Rows	An array of the cells in this column (this is where the user's typing is stored)

Methods

Reset()	Reset this column to blank
Assign(cValue, nRow)	Assign a character string to <nRow> of this column. A numeric is returned indicating success (0) or failure (negative).
AddRow()	Add a row to the column
DelRow(nRow)	Delete a row from the column

Figure 3 - QBEColumn Instance variables and methods

```
function QbeModal(oqbe)
local lAutoEntry, nkey
ScrNew('Selection Criteria')
@ 12,1 say replicate(' ',maxCol()-1)
oQBE:ExprUserDisplay()
oQBE:refreshall()
do while .t.
    status('F2/Esc-Finish,F3-Clear '+;
        'query,<-Edit criteria')
    do while nextkey()=0 .and. ;
        .not. oQBE:stabilize()
    enddo
    nkey:=inkey(0)
    do case
        case TBApplKey(oQBE,nkey)
        case nkey=K_ESC .or. nkey=K_F2
            exit
        case nkey=K_F3
            if YesNo('Clear down enquiry '+;
                'and start again ?')
                oQBE:reset()
                oQBE:refreshall()
                oQBE:ExprUserDisplay()
            endif
        case (lAutoEntry:=(upper(chr(nkey)))$;
            'ABCDEFGHIJKLMNPOQRS'+;
            'TUVWXYZ1234567890=>$<') ;
            .or. nkey=K_RETURN
            * edit criteria
            if lAutoEntry
                * do not waste the key pressed
                * stuff it back into the keyboard
                keyboard chr(nkey)
            endif
            qColGet(oQBE)
        endcase
    enddo
return (NIL)
```

Figure 4 - QBEModalO - A modal use of the QBE class

umns can adopt the full complement of rows. Indeed `QBE:addColumn()` displaces the `TBrowse:addColumn()` method so that it can 'flesh out' new columns as they are added.

The `QBE:settle()` method is typically called after assigning a value to a cell in the query matrix. The purpose of `QBE:settle()` is to ensure that there is always one and only one blank row as the last row of the query. To do this, it repeatedly uses `QBE:AllColumnsBlank()` method to decide whether the query contains embedded blank rows, multiple blank rows or no blank rows and uses `QBE:delRow()` and `QBE:addRow()` to correct any problems that it finds.

The `QBE:exprClipUpdate()` and `QBE:exprUserUpdate()` methods are the real intelligence of the `QBE` class. They assign the correct strings to the `QBE:exprClip` and `QBE:exprUser` instance variables appropriately. In addition `QBE:exprClipUpdate()` also ensures that, as it changes `QBE:exprClip`, it also creates the appropriate code block for `QBE:exprBlock`.

Both update methods work in the same way. For each row they process each cell. An expression is generated for each cell based on the `QBECOL:exprClip` (for Clipper) and `QBECOL:heading` (for the user). Data types are converted from character to the necessary data type to perform comparison as needed. Each cell is ANDed with each other cell on the same row and the whole row enclosed in parenthesis to ensure correct evaluation. Each successive row is ORed with previous rows.

As each cell is evaluated, simple features are processed. For example, the keywords NOT, BLANK and TODAY, case insensitivity for

0	assignment accepted
-1	no parameter following operator
-2	no space following operator
-3	'contains' operator can only be used with character/memo data
-4	usage of both 'contains' operator and 'substring' operator is a logical contradiction
-5	'substring' operator is not supported for non-character data
-6	relational operators cannot be used with BLANK keyword

Figure 6 - `QBECOL:assign()` return codes

character strings and the importance or otherwise of trailing spaces are all catered for.

For the `QBECOL` class, the methods are straightforward, and the intelligence of the class lies in the `QBECOL:assign()` method. `QBECOL:assign()` validates a new value for a cell and accepts or rejects the assignment on this basis. In effect it is a simple parser. Figure 6 shows the return codes and corresponding meanings.

Note that the `QBECOL` class does not contain a code block of the expression represented by the column (ie a fieldname in all probability). The expression is always represented by a character string. This might seem primitive, as we are all being encouraged to use code blocks instead of macro substitution (and quite right too), but in this case the query is better optimised by avoiding individual code blocks. The problem is that the programmer needs a single instance variable containing a code block which evaluates to true or false. If every field is represented as a code block, the `QBE` code block would contain a large number of `EVAL()`s. The concatenation of field name strings and compilation of the expression in its entirety is a significantly faster solution.

Potential Improvements

My example has been kept simple for demonstration and explanation purposes. However, a real world Query By Example would benefit from a number of improvements.

The facility for the user to add columns to the query helps to model real world relationships. With the addition of an expression builder, calculated or virtual fields could be added and then queried as any other field. For example, it should be possible to query a calculated field TOTAL COST, where TOTAL COST is the product of fields QUANTITY and PRICE.

Perhaps more importantly, the query should allow a set to be described based on information supplied by related files. For example, it should be possible to select all invoices for which one of the line items is 'widgets'. Such an enhancement implies the existence of an active data dictionary which could be called upon to supply relevant information about relationships.

An easier enhancement would be to add a method such as `QBE:exprSQL()`, which would create a SQL expression based on the query matrix.

Finally, it is possible to write generic routines which dissect the query and attempt to use available indexes to optimise the query. At the simplest level, the routine would look for single field enquiries of exact matches eg all companies based in Nottingham. The optimisation routine would look for an index based on the CITY field and, if found, perform a SEEK "NOTTINGHAM". It is possible to write more intelligent optimisation routines (as Fox Software has done for FoxPro 2) but even the most simple will reap great time savings.

Use

The use for a programmable Query By Example is not limited to an *ad hoc* report writer. It would be a relatively simple matter to allow the user to pop up a fresh query window from within a browse and allow colour settings for a set of records to be set according to a query. The number of query/colour setting combinations need not be limited to 1. Thus the user could browse a full table and easily identify records by the colour in which they are displayed.

Summary

Query By Example is a powerful and easy to use tool for users. Presented as a class it is both flexible and easy to use for the programmer. The same facility presented only as a set of functions is not nearly as flexible.

EXE

```
function QColGet(oQBE)
local nError:=0
local nRow:=row()
local nCol:=col()
local oCol:=oQBE:getcolumn(oQBE:colpos)
local getList:={}
local cEntry:=oCol:rows[oQBE:rowPointer]
do while .t.
    @ nRow,nCol get cEntry picture '@S10'
    read
    if lastkey()=K_ESC
        exit
    endif
    nError:=oCol:assign(cEntry,;
        oQBE:rowPointer)
    if nError==0
        oQBE:settle()
        exit
    else
        Alert('Invalid entry', ('Ok'))
    endif
enddo
oQBE:ExprUserDisplay()
oQBE:refreshall()
return (NIL)
```

Figure 5 - `QColGet()` - Edit the currently highlighted cell

Guy Smith is a freelance writer and has developed in Clipper since the Winter '85 release. He is the author of the *Capella Library*, an application development library for Clipper 5, and co-author of a *Programmer's Reference to BPS's Visual Interface Library*, which we haven't reviewed yet - sorry Guy. Guy can be contacted on CompuServe at 100014,1724 or on CIX as smithg.

The full source code to Guy's `QBE` class, together with an example application, can be obtained by sending in a disk as per the rules laid out on Page 3, column 1. Please mark your envelopes 'QBE'. Note that the `QBE` class code requires SuperClass 2.1.

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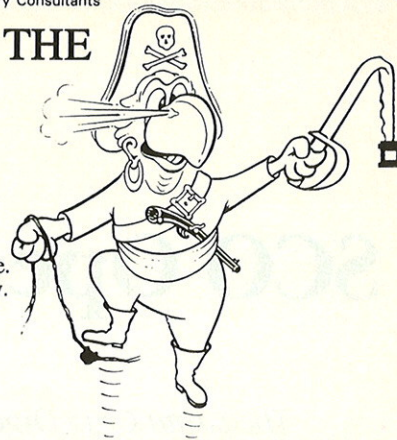
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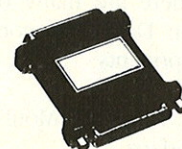
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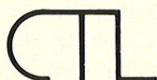
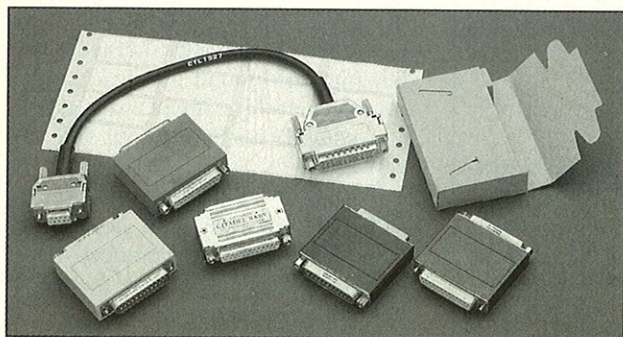
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SCO Open Desk Top Release 2.0

The Santa Cruz Organisation has recently delivered Release 2.0 of Open Desk Top. Alain Williams takes a look at some of its major features.

Open Desk Top (ODT) is intended to be SCO's answer to Microsoft's Windows 3. It is advertised as providing a 'UNIX-based integral graphical environment'. The graphical emphasis is perhaps misleading, as there are many other good features. Open Desk Top contains the following components:

- X Windows (Motif) based graphical interface.
- TCP/IP Networking: telnet, ftp, snmp, LAN Manager and the UNIX *r* commands.
- A PC Interface consisting of a DOS file server and login support.
- Enhanced file system support: NFS, EAfs (a fast file system with long names and symbolic links).
- NIS (explained below).
- DOS under UNIX with Locus' Merge, providing DOS 5.0, LIM 4.0 support.
- Security to the DOD C2 level.

Despite the emphasis on graphics, most ODT applications are (still) character based. These can be run either in a 'terminal window' on the desk top (with X-term), or in a full screen, text mode console window - I prefer the latter as it is faster and the text is bigger. There is an SCO catalogue listing several hundred graphical applications, and more are being developed.

Graphical Interface

As mentioned above, the Graphical Interface is based on the X windowing system. It provides a prettily coloured 'desk top' with icons, menu bars and all the usual mouse-driven gizmos. You are probably used to the Windows 3 environment: superficially this is the same. On top of X Win-

dows, ODT uses the OSF Motif Widget Toolset, a set of application libraries designed to produce a uniform *look and feel* to graphical applications. The desk top environment itself is IXI's X.desktop 3.0 - a UK product.

To do real work, you will need to buy some third-party applications. SCO does provide a few applications to get you started: a mailer (send/view e-mail), X-term (which gives an ASCII command-line session), and the usual clock, calculator, draw and preference configuration utilities.

I tested the environment using a third party typesetting package (eroff). This worked well enough, although it occasionally crashed, I think because eroff doesn't conform to Motif rather than an SCO problem.

There were some irritations. For instance, the hot key sequence to shut a window/application varied considerably between the SCO supplied applications. If they can't get it right, why should anybody else be bothered? It is these little things which really make you understand how important it is to conform to standards - whether you like them or not.

Another irritation is that ODT is based on X Windows version 11.4. Version 11.5 has been available since August last year, and many other UNIX vendors supply it. This is slackness on SCO's part.

Networking

To anyone who uses UNIX and UNIX-based networks every day, there will be few surprises here. The networking system is based on TCP/IP and provides the usual abilities, of which the most important are:

- NFS. This is *the* UNIX file system sharing protocol. It allows you to treat a file system on another machine as part of the file system on your local machine, which

is incredibly useful. NFS is also available for many other platforms, including Apple Mac, VAX/VMS and IBM MVS. One note: RFS, the USL provided version of NFS, is not supported - but this is not a great loss.

- Telnet/rlogin. Remote login to and from other machines. This means is that, without leaving your local machine, you can login to another machine and work just as if you were sitting in front of it (well, almost).
 - FTP. This allows you to copy files between machines on the network - something you do when the option of remote mounting the file system is not available.
 - NIS. An admin tool which ensures that passwords are kept consistent for a user across the network. NIS does have its problems, but is a useful tool in managing a UNIX network.
 - Sendmail and SMTP. These are electronic mail utilities, very useful - but a devil to configure.
 - PC-Interface (from Locus), DOS machine connectivity. This provides access to the UNIX file system as a virtual D: drive, and the ability to use a DOS box as a VT220 (ANSI) terminal and login to the UNIX host. PCI works over either Ethernet or RS-232 lines. I tested it over Ethernet, and found that loading files over the network is about as fast as from an (old and slow) 80ms local disk. It is very usable.
- Two negative points. You cannot see the DOS disk from the UNIX host (which would be handy), and you need to buy extra software from Locus at about £130 per DOS machine.

Note that much of the above won't be very useful to you if you run a Novell IPX/SPX network. In fact, SCO has only just an-



nounced support for this. At time of going to press I have yet to see it. SCO says that the facility will cost you about £300 extra, and will probably be bundled into the next release of ODT. It will supply the protocol stack, *mut* (login) and an API, but you will have to wait longer for a version that works as a Netware client. There are no plans to make it a Netware server (shame).

Products are also available for IBM mainframe, OSI/X.400 connectivity.

Enhanced file systems

In addition to NFS (discussed above) SCO supports seven other file system types. Five of these are various UNIX and XENIX file system variants (mainly to do with different block sizes), but there is also 'EAFS', which is similar to the BSD Fast File System, and supports long file names (up to 255 characters) and 'Symbolic Links'.

Symbolic Links allow you to reference somewhere on another file system (possibly on another machine) but using a name that appears to be in the first file system. Imagine that you had filled a disk partition, but had plenty of room to spare on another disk. If you move the files over, you need to rewrite your programs so that they know where their data has gone. But if you create a symbolic link in the original location which points to the new one, everything will work as it did before.

Symbolic Links are very useful, but should be used sparingly - otherwise you will convert your file trees into bramble bushes.

Also available is the DOS file system. This allows you to mount a DOS floppy or partition as part of your UNIX file system. You can then use all the UNIX tools that you love (well, at least I do) to manipulate your DOS files.

CD-ROM users will like to know that the High Sierra (ISO 9660) file system is supported - I wish that I had such a drive.

DOS under UNIX

Here is a useful feature. If one types `dos` at the system prompt (or clicks the appropriate icon on the desk top), one ends up with a `C:\>` prompt. You can now run your favourite DOS programs. Any printing will be sent (once the system has been properly configured) to the UNIX spooler. It is possible to run multiple DOS sessions simultaneously.

The DOS emulation works by using the virtual 8086 mode of the Intel chip, and, unlike OS/2 or Windows, you can't (in my

experience) crash UNIX from within the DOS box. Because it is based on virtual 8086 mode (ie IBM XT compatible), you can't use 286 or 386 features such as protected mode, nor can you run Windows 3.1. However, you can access LIM 4.0 memory if you need it. In spite of these limitations, the DOS emulation is a really useful environment.

Security

To comply with the US C2 requirement for government contracts, SCO includes some extra security features not supplied with traditional UNIX. You can choose from four levels (from high to low) the degree of security you want. These levels are new with this release and were introduced because many people didn't want the extra administrative burden of the high-levels.

Many manufacturers offer a C2 capability - and they all, unfortunately, implement it in different ways. SCO's is licensed from Se-

cureWare Inc and is a mixture of kernel and user-level code.

Features include the ability to restrict certain system resources such as printing, using `su` or `ps` and then running the set-userid programs or auditing (disk logging to you). The highest level will record every file open, close, program run... an excellent way of filling unwanted disk space. I switched this level on and filled 14 MB in five minutes. This is all well and good, but who is going to bother to look at it all?

More practical measures include locking users out if they get their password wrong too many times, forcing regular password changes and checking passwords for obviousness. I think that ODT could do more in this area, but this is a start.

XENIX support

ODT allows you to run XENIX binaries, and also cross compile for XENIX systems.

History of SCO ODT

In the mid 1980s, Microsoft brought out a version of UNIX designed to run on IBM PCs called 'XENIX' (for 'Extended UNIX'). Soon afterwards it transferred its interest to the Santa Cruz Organisation (based, you won't be surprised to hear, in Santa Cruz, California). Microsoft has retained a large share holding in SCO. Xenix rapidly became a popular workhorse for small departments on which they ran their accounts, databases etc.

It was an attractively priced effective solution, partly because of the relative cheapness of IBM AT compatibles. XENIX wasn't glamorous, but it did get the job done. SCO essentially *owned* the PC platform based UNIX world.

XENIX was so important that, as part of the UNIX standardisation effort, it was merged back into the mainstream AT&T (now USL) UNIX to make Version V.3.2. XENIX is still available as a small, mean system for those who don't need the features of full-blown UNIX.

Meanwhile, other versions of UNIX had progressed and acquired lots of wacky new features, including networking (based on TCP/IP), Networked File Systems, X Windows, internationalisation features (ie the ability to *talk* to the user in his mother tongue - NLS) and more.

SCO didn't want to get left behind by not offering these features. SCO wanted to be able to compete on the desk top, ie against the emerging Microsoft Windows and IBM's OS/2. Additionally, XENIX didn't really work with DOS or DOS networked machines. An extra pressure was introduced by the US government, which two years ago mandated a minimum of a DOD C2 (security level) in the software that was supplied to it.

XENIX had to be replaced, but SCO did not want to loose the large installed base. Three years ago, SCO introduced the first (beta) version of ODT. The recent release 2.0 of ODT introduced many new (for SCO) features and maintained upwards compatibility with XENIX.

It is worth noting that SCO ODT is release UNIX V.3.2.4, version 4 based on System V release 3.2. It is **not** based on System V release 4 - as many people wrongly inferred from some SCO marketing information. Although SCO has introduced some V.4 features, it has a long way to go to become V.4 based, and refuses to say if it will do so.

Many ISV's produce 286 XENIX binaries, so this feature will make their life much simpler. Incidentally, you can also cross compile for DOS systems. Mention of compilation brings us to...

The Development System

The Development System is a C compiler supplemented with a few other bits and pieces. Actually you get *two* C compilers. The main compiler, `cc`, is the Microsoft C V6.0 (so, as usual, UNIX remains one release behind its DOS counterpart). The alternative is the AT&T C compiler, available through the `rcc` command. SCO also details what you need to do if you wish to get the (much better) `gcc` compiler working, which is part of the GNU public domain set of utilities. However, it's down to you to get hold of `gcc`.

The standard UNIX utilities make, `sccs` (Source Code Control System) and `lint` a C program checker are all included. Time invested in mastering these utilities is well rewarded. The kit also contains `lex` (a Lexical analyser) and `yacc` (Yet Another Compiler Compiler). I use these a lot for generating small language compilers and for file conversions.

There are four debuggers available: the traditional UNIX `adb` and `sdb`, `dbxtra` (which knows a bit about C++), and `cv` - Microsoft's CodeView, which looks and works very much as it does in the MS-DOS environment. Being a UNIX traditionalist I still prefer `adb`.

For those wishing to get into X windows, the minimum tools are supplied, together with the X libraries and Motif widget libraries that you need. `bitmap` is a rudimentary tool for creating and editing bitmap images. These can be used for icons, cursor shapes and background patterns. There are several other tools of the same sort.

Documentation is plentiful - about 3,000 pages in the X and Motif manuals. A few example programs are provided to get you started. I've played with the examples and made them work, but I should warn you this is not really something which can be picked up by browsing the API reference - there is a lot more to it than that, and a training course(s) would help. If you want to get results quickly, you will probably have to rely on third-party tools such as 'GUI Builders'.

Although there is no bundled C++ compiler, many of the header files include C++ compatible function declarations. Since these also have to work for XENIX they can be quite messy, but at least they

work and *you* don't need to worry about the inner details.

What's new?

The most visible/important changes from the first release of ODT two years ago are:

- More RAM supported (now up to 512 MB).
- Configurable security levels.
- Symbolic links and long files names in the new EAFS.
- Boot time loadable drivers (something to worry about if you have non standard devices which you need to use to install your system).
- Upgrade of X from 11.3 to 11.4, and the inclusion of IXI X.desktop.
- LIM 4.0 support included, upgrade from DOS 3.X to DOS 5.0.
- Networking: enhanced networked printing with Berkely's LPD, PPP (Point to Point Protocol), SNMP included, Automounter daemon, and NIS.
- The C compiler is now ANSI compliant, with options for POSIX, `xpg3` and `svid` compliance. `Lint` understands `void` pointers (at last).
- The Ingres Database package and related components are no longer bundled in ODT.

In addition to these, various other less important components have been upgraded - but, unless one had a particular compatibility problem with one of them, I doubt that these changes would be of interest.

What you need

To run SCO ODT you will need an 386/486 PC with at least 8 MB of RAM and 120 MB of hard disk. These are the minima for the *personal system*, the ODT server needs more. I would recommend a minimum of 16MB of RAM and 250 MB of disk if you intend to do real work on the system and use all the features.

SCO works with ISA, EISA and MCA buses, but you should specify that if you have an MCA bus when you place your order, and you should also say if you have a 3.5" or a 5.25" floppy drive.

You ought to have a QIC tape drive as well. UNIX systems are larger than DOS ones, and you will soon get bored of backing up to floppy. If you do have a QIC-24/QIC-02 drive

you can get ODT on tape - much faster to install, and just a little bit cheaper. (If you have a CD-ROM, ODT is cheaper still - about 15%).

If you want to attach it to a LAN you will need an Ethernet card. Choice of brand is important here; get an SCM (Western Digital) or 3Com card, but *don't* get a Novell NE1000/NE2000, as it won't work (they don't seem to work with TCP/IP anywhere).

Be careful, after booting UNIX does **not** use the machine's BIOS and so needs to be able to drive the hardware directly, and it pushes it **much** harder than MS-DOS ever could. SCO does a good job at working on most PC platforms, but it does suffer from hardware incompatibilities on some of them. So don't buy cheap hardware, and specify that you will be running SCO ODT when you order the machine (so that you can send it back if it doesn't work). If in doubt check in the *SCO Hardware Compatibility Handbook*. Unfortunately this doesn't list the offerings of many of the smaller clone manufacturers - not because they won't work, but because they haven't been tested.

Oh, one last thing: you will need two feet of shelf space for the manuals that come with the Personal System alone.

Installation is quite smooth. You get asked a lot of questions about the hardware, and you have the option of installing the whole product or selecting parts of it. After this you need to set up user accounts, configure networks...

Bottom line

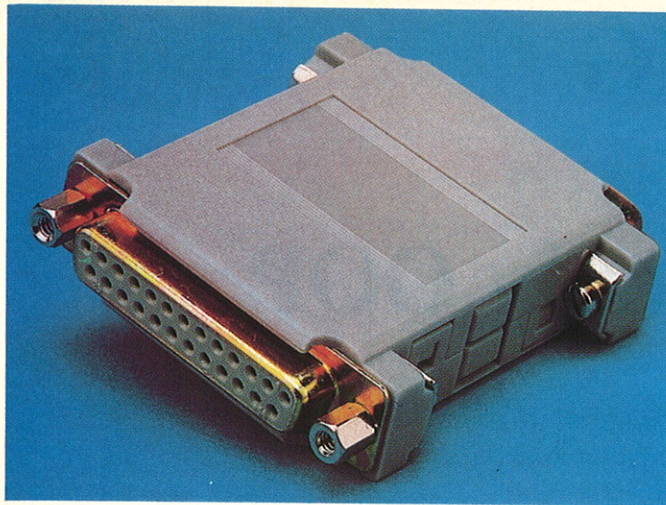
OK, what does it cost? An ODT personal system costs £1150, and an ODT server costs £2300. The personal system is essentially a two user licence, the server an unlimited user licence with some additional networking server utilities. If you want the development system you'll have to find another £995, and then £795 for a C++ compiler.

EXE

Alain Williams is a director of Parliament Hill Computers Ltd, a small UNIX systems consultancy, developer of 'pbLOGIN' which is a secure, configurable, network knowledgeable UNIX login tool. Alain is also the editor of the EurOpen newsletter, and may be reached on 0734 461232 or addw@phcomp.co.uk.

SCO is on 0923 816344.

Peter Collinson is on holiday.



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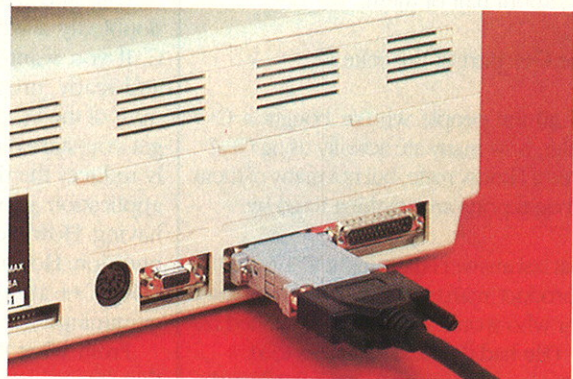
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Not necessarily OOP

*Discussion of OO and C++ seem naturally to go together.
Mike Banahan points out that they aren't always the same thing.*

Whenever you get amongst a group of those hairy-handed sons and daughters of toil, the hardened C++ users, conversation has a knack of moving around to the same old question. Then, when you've finally worked out who did have the goat vindaloo and extra chapattis, the second most popular argument gets started up. It goes along the lines of this hairy old joke:

Q: How many people work in your office?
A: Oh, about half of them.

The C++ port of this joke is:

Q: Of all the people who've bought a C++ compiler, how many are actually using C++?
A: ****ed if I know mate, but not many of them if the bug reports are anything to go by.

That last answer is copyright © 1992 to the C++ product manager of a major compiler vendor who would kill me if I mentioned his name. (He had the extra chapattis too).

There's a lot of truth in it. C++ offers the kind of type-checking that even an ANSI C compiler is unable to provide unless it chooses not to conform to the Standard and throw away the backwards compatibility that the committee spent hundreds of hours carefully tailoring in. That alone is a worthwhile improvement. Throw in a few simple concrete classes like Strings and Associative Arrays, with the relevant bits of operator overloading, and you've already started working in a new world compared to Old C.

The subjective quality of the software changes enormously. Robustness creeps in, of a kind that C programmers just aren't used to. Instead of the program crashing (on DOS the machine hangs, under UNIX you get a core dump) it carries on running and you can as often as not see from the output what is wrong with it. This more graceful kind of bug is appreciated by the users too - they don't actually rush out and thank you, but the foul language is more muted.

C++ and a few concrete types is undoubtedly a worthwhile improvement on C. If you want to crank out some rough-and-ready programs for Windows, then most of the PC compiler vendors provide a get-you-started class library which seriously reduces the time it takes to get a simple application going. This is all stuff worth having. However, it leads us on to the third question: How many of the people actually using C++ are doing Object Oriented Programming?

From what I've seen so far, I'd venture that the answer would be a very small number. Of course, we could argue about what OOP really is, but if you read the background literature, there's a consensus of sorts starting to emerge. We'll have to assume that OOP embraces Object Oriented Designs too: we're talking about software systems which do more than play around with a few unrelated user-defined types (or Abstract Data Types if you want to use a posh term). Instead, we need to look at the purpose of inheritance and polymorphism.

```
class String
{
    // private stuff
public:
    String(const char *);
    virtual ~String();
    virtual size_t Length();
    String &operator =(const String&);
    friend String operator +(const String &, const String &);
};

class FontString: public String
{
    // more private stuff, including storage
    // of font information, which we trick a
    // String into doing for us
    String fonts;
public:
    FontString(const char *, int pointsize);
    FontString &operator =
        (const FontString &);
    friend FontString operator +
        (const FontString&, const FontString&);
};
```

Figure 1 - String and FontString classes

```
// include relevant headers
void do_good_stuff(String &r1, String &r2)
{
    // Lots of clever things, then:
    r1 = r2;
}

main()
{
    FontString fsl("abc", 12)
    String s1 = ".EXE";
    do_good_stuff(fsl, s1);
}
```

Figure 2 - A deliberate mistake

Many, many users of C++ appear to misuse inheritance because of a fundamental misunderstanding of its purpose. This is not surprising, because it's hard to find many descriptions of how to do it right. Inheritance is often wilfully (or it might be through ignorance) presented as a tool for code reuse. It's perniciously easy to swallow the message and to use it in that way, although there's increasing evidence of the damage that results to your software structure as a consequence.

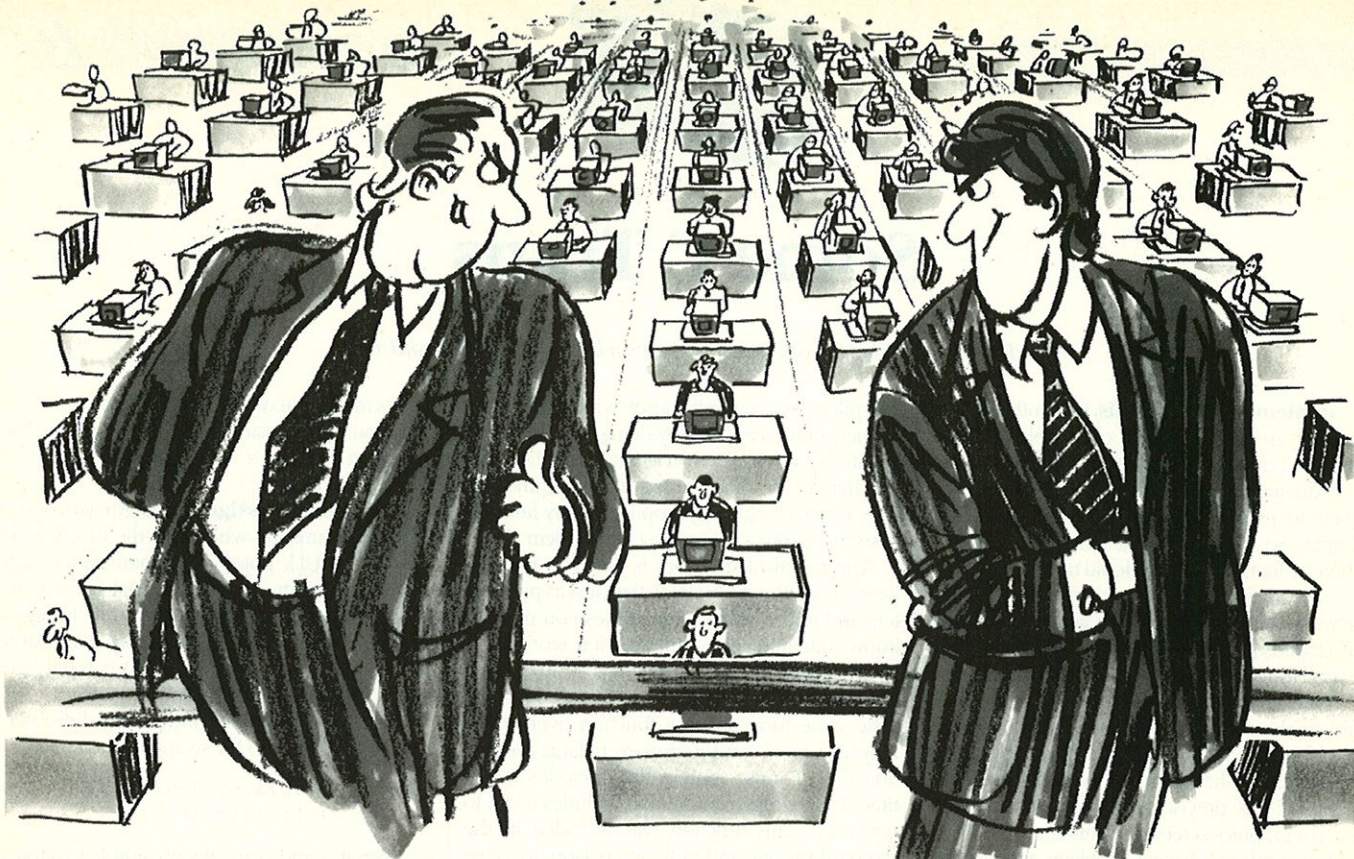
Figure 1 contains an example of reuse-driven inheritance giving us some nasty results. Assume we've got a class String (you've probably got something suitable lying around somewhere). You want to implement an augmented version, say for a word processor, which supports font information too. Noticing that you've already got String, you decide to use it as the basis for FontString (after patching up the important member functions to be virtual).

Now, since they are related, we can use a pointer or reference to a FontString anywhere we can use a pointer or reference to a String, can't we? After, all that's the whole point of inheritance isn't it? Well, take a peek at Figure 2 and tell me what happens.

Got it? It's just that (*but, to paraphrase the Rev Awdry's 'Toby the Tram Engine', I cannot tell you any more, or I shall spoil the next column.*)

EXE

Mike Banahan is chairman of the European C++ User Group, and may be emailed as mikeb@hoskyns.co.uk. For more information about ECUG membership, please call 071 253 5121.



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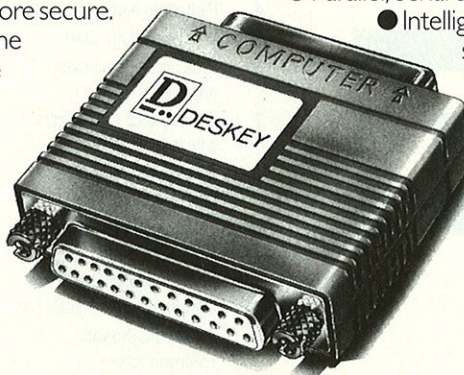
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Some C Traps

Francis Glassborow offers four C traps which are worth avoiding.

Implementation Details. I recently needed to make an alteration to an old, stable program of mine. I needed the new version quickly and I had discarded the original compiler. Finding space to re-install it would mean a major reshuffle. So I chose to use another compiler. Thereby hangs an instructional tale.

The original source was reasonably portable between compilers (or so I thought) as it had been developed on one compiler then reworked on a second from a completely different supplier.

I replaced the project file with an equivalent and set the compiler to work. Everything compiled first time with no significant warnings. I ran the result. Half the information on the screen was missing. To be precise, all text information written to a graphics screen was missing.

I remembered having problems when I developed the program. I checked the library references for both the current compiler and the original ones. All three gave identical specifications for functions handling text on a graphics screen.

Two hours later I managed to crack it. For some reason, I had written my own direct call to DOS to set the graphics mode. The original

compilers were entirely happy with this. So was the new one except that, by doing so, I had failed to initialise a struct containing screen information that all the other screen handling functions were using. Using the appropriate library function to set the graphics mode fixed the problem.

The moral of the story is that you need to know more about a function than just its parameters and return values. Sometimes you need to know something about the way it is working.

Alternatives to scanf(). Most C programmers learn to avoid scanf() and replace it by some form of input function over which they have more control. However a large proportion (and I must confess that includes me at times) use a replacement that includes a call to gets(). This function was included in the standard for one and only one reason, to avoid breaking millions of lines of code.

The use of gets() in a program is an excellent way of placing a potential disaster in your work. There is no way that you can control the length of the input when using gets(). If some user manages to type in a line longer than your provided input buffer, your program is broken. The

results may, or may not, be harmless.

If you are still using gets(), check out the definition of fgets(). I think you will find it meets your needs.

NULL pointer assignments. Are you one of those programmers who think the best way to handle a 'NULL pointer assignment' message when your program ends is to patch the compiler to remove the message? If you are, I suggest that you never recompile your work for large models. The warning will almost certainly go, but you will be writing over DOS instead.

And Finally. What is the potential problem with this little macro for swapping two ints?

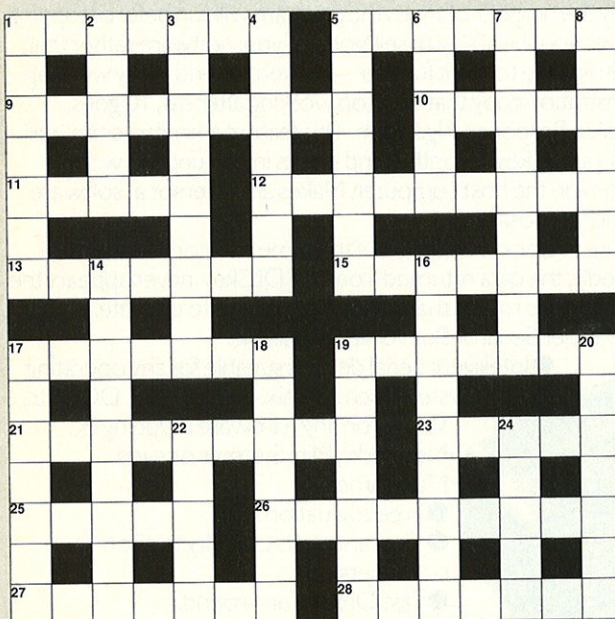
```
#define swap(a,b) ((a)^(b);\
(b)^(a); (a)^(b);)
```

Even if a and b are always simple variables, there is still a little nasty hiding away.

EXE

Subscriptions: individual £12, student £6, corporate £50. For further information about CUG(UK) write to Francis Glassborow at 64 Southfield Road, Oxford, OX4 1PA or ring 0865 246490.

OCTOBER .EXEWORD



ACROSS

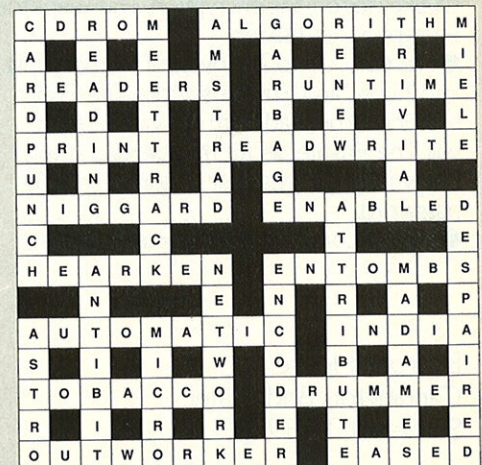
- 1 American directory? (7)
- 5 Like BASIC or COBOL initially (7)
- 9 Market to directorate flexible old hard wiring system (9)
- 10 People who dress up to them (5)
- 11 Victorian teacher coming from the bush erratically (5)
- 12 Radiators for chips (9)
- 13 That's the puzzle for now! (7)
- 15 Erased the data from store (7)

'EXEWORD' compiled
by Eric Deeson

- 17 COBOLic governors (7)
- 19 Good person spoke to God and broadcast indiscriminately (7)
- 21 Cutting the pressure down (9)
- 23 Wipe out age of Home Counties (5)
- 25 Bones from St Paul? Nasty! (5)
- 26 Worked out worth (9)
- 27 Hanks of hair (7)
- 28 Element of the valley (7)

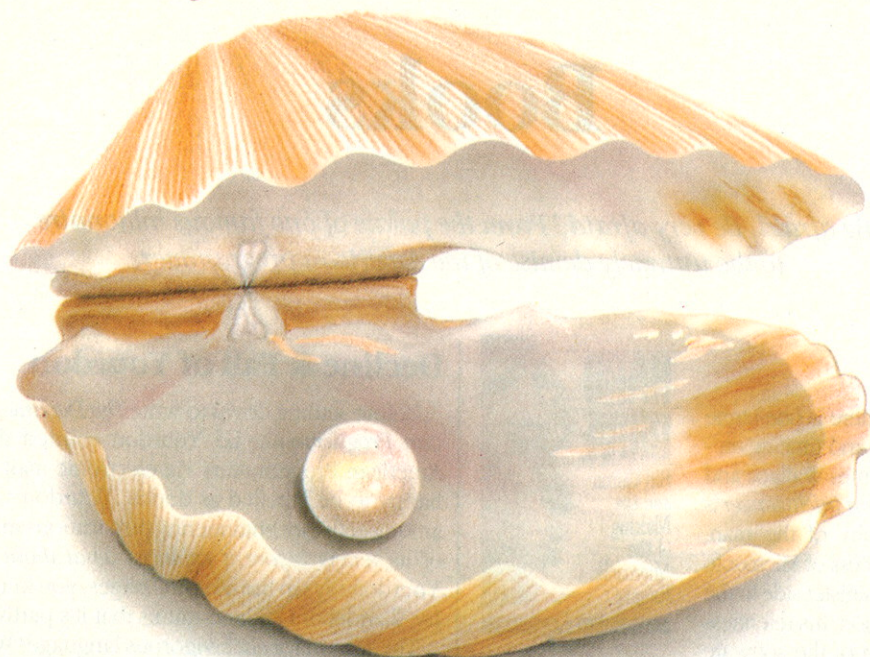
DOWN

- 1 Overcome what's almost true and get data (7)
- 2 It's in the logical table and Pliny's wine (5)
- 3 Tough going with US work and notes of debt (9)
- 4 Plotted on a grid (7)
- 5 Its 2 gives 0001 (3,4)
- 6 Data stores for circular arguments? (5)
- 7 Someone so insignificant s/he has no record (9)
- 8 Thousand almost issued but badly employed (7)
- 14 Needed if something's 3 (9)
- 16 Does such motion result from an endless loop? (9)
- 17 Gone wrong? Criminal! (7)
- 18 Hangs around with confused toilers (7)
- 19 Units of information-carrying energy (7)
- 20 Place for shepherdesses in the East before (7)
- 22 Melts to cut current (5)
- 24 Greek in programmer's Sgarret (5)



SEPTEMBER .EXEWORD

When you look inside...



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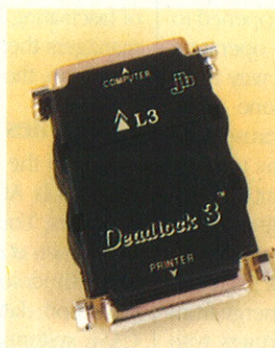
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Books

'Be afraid. Be very afraid.' From the palate of one famous billionaire to the untimely demise of the American programmer.

He eats pizza

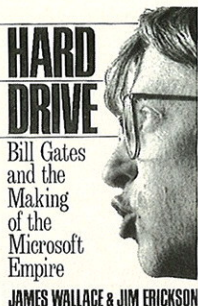
In the software industry there is one name that seems to crop up time and time again - Bill Gates. *Hard Drive* by James Wallace and Jim Erickson of the *Seattle Post Intelligencer* is not just another hagiography of the man; along with the fairy-tale success of Microsoft, it exposes the darker, more sinister side to the Gates character; his motivation, his relentless drive for World domination of the software industry, and the ruthlessness of his approach.

Wallace and Erickson paint a picture of Gates as a man, born into an affluent, Seattle family, who got more than his fair share of lucky breaks. Indeed, years before the PC was a glimmer in the eyes of the suits at IBM Boca Raton, Gates was striking his first business deal at Lakeside Prep School. Lakeside was where he first met MS co-founder Paul Allen and it was here that he began his love affair with computers.

Testimony to Microsoft's lucky streak is the 10 year marriage to IBM. Had it not been for Gary Kildall of Digital Research 'flunking the deal of the century', IBM would never have asked Microsoft to write DOS. There's more. Microsoft didn't have to spend vast resources on writing the operating system either - a small Seattle-based company called Seattle Computer Products had already written 86-QDOS, an 8086 port of Digital Research's CP/M operating system. Gates just happened to be in the right place at the right time. By first licensing the operating system, and later buying it outright, Microsoft paved the way to its \$200 million a year income from sales of MS-DOS alone. Also, Presentation Manager didn't appear by magic, but because IBM desperately needed a GUI for OS/2, and Microsoft had one to offer. Gates held all the cards. Microsoft continued development of Windows along with OS/2; but when Windows started selling, Gates dropped OS/2 and divorced IBM.

Luck wasn't the whole story. Gates had a vision; a vision of Microsoft software on every desktop. He extracted every ounce of energy from his employees to reach this end. He bullied business partners with what Wallace and Erickson refer to as 'intellectual brow-beating' to get his way. An example: in 1985 he forced John Sculley of Apple to abandon Apple's MacBasic project in favour of MS-BASIC, by threatening not to renegotiate the MS-BASIC licence for the Apple II, at that time Apple's most popular computer. Many observers believed that MacBasic was the better product.

With an appetite for pizza and hamburgers, and the dishevelled appearance of a skinny 17 year old with greasy hair and dandruff, Gates has more in common with a nerdy programmer than the CEO of the most powerful software company in the world. *Hard Drive* gives a fascinating insight into William Henry Gates III, one of the richest men in America, and how he got there.



Decline & Fall of Yourdon

Before settling down to write *The Decline And Fall of The American Programmer*, Ed Yourdon courted the opinions of a few American Programmers via electronic mail. Not all of them were happy to be labelled as dodos. Yourdon's book must be unique among software engineering publications in giving major criticisms of its tenets *before it explains what those tenets are*. Whatever Yourdon says in the next 300 pages, you know by page eleven that Irv Wendel of Oakland thinks that it's partly (quote) 'bullshit'.

The reason for such vigorous language? Well, this time Yourdon is out to scare. The most worrying aspect about Western software managers, he says, is that they aren't worried at all. They think they're doing okay. And Yourdon isn't put out when his drinking partners point out that they *are* doing okay:

"Tom DeMarco shared a panel with me in Singapore, and confronted me with a blunt question. 'If the American programmer is in such peril, why is the US share of the world software market increasing?' Ummm...err...ahhh. I had no answer."

Despite his candour, Yourdon is largely unconcerned by the lack of statistics to back his scenario of Doom. It's true that the developing countries which he points to as the new champions of programming are currently behind the States, technically and organisationally. His own appendix describing a visit to India, although full of fascinating insights, tacitly confirms this. The difference is that the managers there know they must improve. The Americans - and by extension, those of us in the 51st state too - do not.

If Weenies ruled the Earth

One of the chapters of *Decline* is dedicated to a quick survey of CASE tools. At one point, he charts the movements in CASE in the last ten years; Yourdon-DeMarco and Constantine versus Martin, Bachman, Chen *et al*. The premise is that the information engineering and SA methodologies are evolving towards a middle-ground, that combines both data (which Martin is hot on) and function (which the older CASE systems concentrated upon). The diagram which he uses to illustrate this point lists the IE folk as CEOs (company chairmen); Yourdon and co are listed as 'Tech Weenies'.

While it may come as some surprise to junior developers to discover the man who makes them spend hours on those fiddly little hand-drawn design diagrams actually sees himself as one of them, Yourdon does spend a lot of time talking to programmers.

He also believes that many managers do not. One of Yourdon's most fascinating chapters came about after he posted a message onto one of CompuServe's electronic bulletin boards. In a nutshell, it asked programmers what they would say to their managers if they weren't scared of getting sacked. He prefaces it:

'Read this chapter as if it were a memo from one of those programmers whose name you can't remember, whose scruffy face you see only at Christmas parties and other ceremonial gatherings.'

Yourdon's purpose isn't just to grab back some hacker credibility. One of the statistics which he and his opposition do agree

Title: *Hard Drive*

Publisher: John Wiley

Pages: 426

Authors: James Wallace & Jim Erickson

Price: £14.95

ISBN: 0-471-56886-4



on is that a very good programmer can transform any company's production statistics, regardless of tools, techniques, and programming environments. He quotes Sackman, Erikson and Grant's 1968 study of twelve programmers, each given the same exercise. The best person in the group finished coding and debugging the exercise *28 times* faster than the worst, and the best program was approximately 10 times more efficient (in terms of memory and CPU cycles) than the worst.

Yeah, yeah. We've heard *this* before. What is interesting about Yourdon's survey, however, is the number of positive ideas that float away from the core of general griping. Yourdon lists them, because he feels that one of the main problems with US companies is that the turnover of good programmers is far too high. Losing programmers, he says, is more of a pain. In a high-turnover firm:

'the best people quit, the worst people are fired, and what you're left with is all the mediocre people in the middle. [Also] the workers at the bottom of the organisation are typically *very* junior, often with no more than 6 to 12 months of experience.'

Yourdon and his survey come up with some solutions. In the workplace, one of the biggest gripe about managers is their slipperiness in 'Doomed Project Scenarios'. Managers have an obligation to motivate; but this often means barefaced untruths when a project is clearly heading for disaster. And as one correspondent says: 'People in doomed projects know they are doomed fairly early on. They just never tell their bosses because they assume that's a waste of time (frequently a true assumption)'.

It's hard to provide solutions for these Catch-22 situations but Yourdon does suggest - and for the sake of brevity, I may be stating his case more strongly than he'd like here - that saving one's credibility in front of valued programmers (and thus keeping them for longer) *is* better than sacrificing one's reputation on an impossible project. It also has the advantage of encouraging honesty along the entire command line. Admitting a assignment is up a wrong tree to your programmers - or listening when they tell you it is - also entails telling your boss, too. Praise was universal for managers who 'told it how it was' - up or down the chain.

Dumping bad programmers was another unusual demand. Of course, *all* of Yourdon's sample felt that they were not the programmers in question here, but most agreed that sacking a poor programmer had a greater effect on productivity than hiring a good one. It's also, they added, a lot easier.

But if programmers were happy to see themselves culled, they had to some reservations about how it is currently done. The introduction of *Exit interviews* was widely praised. Yourdon admits:

'Any manager who has participated in exit interviews will tell you that it's frustrating, annoying and discouraging - but as the old proverb says, your enemies are your best critics.'

Not, he adds, that departing employees *are* the enemy. On the contrary, exit interviews with programmers can often clear the air enough to make them your friends. Friends you don't have to pay, too.

The road is long...

'The majority of software development organisations today are far too primitive to take advantage of CASE, new methodologies, or virtually *any* complex technology.'

Another pessimistic view? If it is, then Yourdon is in good company. It comes from his overview chapter of a fundamental principle in *Decline*, described as the 'hottest' idea in the software development industry these days: organisational maturity. Watts Humphrey's work on the long-term evolution of DP companies suggests that it can take as long as a *decade* for a stable DP department to grow wise enough to use - and understand its use - of CASE, quality assurance and software metrics.

If *Decline* is beginning to sound like a jeremiad, broadcasting doom for any company with less than epoch-sized long-term plans - well, in a way, it is. The key point that Yourdon states and restates is that software managers, if they want to survive in the 21st century, should start planning *now*. This doesn't mean forgetting the next week's project deadline, but seeing it as a step to moving the rest of the company onto the next step of its organisational maturity. The length of time to reach full maturity should not be a worry: it should be a relief. After all, the only company that has provably reached full maturity so far is NASA.

There aren't a great deal of fully illustrated solutions in *Decline*. It's not that sort of book. However, like the man in the AA advert, if Yourdon doesn't know how to get out of every mess, he knows some men who do. The final, and perhaps most useful chapter, of *Decline* lists Yourdon's suggested reading: some eighty-seven books that describe why Yourdon is taking the stand that he is.

Decline and Fall is an entertaining, readable book; attributes it appears to have taken to be backwardly compatible with the publications that Yourdon lists. It also, consciously, sticks its neck out. You may not agree with everything it says - I must admit to giggling when Yourdon cited the Alvey Directorate as something those wily foreigners had up their sleeves to destroy the State's supremacy. And I, for one, couldn't stand to read Robert M. Pirsig's 'Zen and the Art of Motorcycle Maintenance' again (all Chautauqua and no action). Nonetheless, *Decline and Fall's* attitude and lucidity recommend it. It's also scarier, in parts, than most horror books.

Dan O'Brien



Title: *Decline and Fall of the American Programmer*

Pages: 352

Author: Ed Yourdon

Publisher: Prentice Hall

Price: £19.95

ISBN: 13-203670-3

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McGregor Boyall is the UK's leading PC & Unix specialist recruitment consultancy, with a long and successful track record of placing candidates with backgrounds in 'C' development on DOS, Windows, OS/2 and Unix platforms. We have, consequently, built strong working relationships with a range of clients, including software houses, consultancies, merchant banks and other large end-users.

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City £22-30,000
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Surrey £15-25,000
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IMAGING SYSTEMS

Berks to £29,000
This highly successful, well established systems house currently seeks to recruit a Senior Analyst/Programmer. As a market leader in the field of OCR/Data Capture and Imaging Systems, they are looking for someone fairly senior with at least 18 months experience of developing with Windows 3.0/SDK and some experience of project management. Ideally candidates will also have a degree and will have come from a Financial/D.I.P. background aged in their mid 20's to early 30's.

C++/MS-WINDOWS

Thames Valley to £23,000
Specialising in PC based Voice Network Management tools, our client currently seeks to recruit a senior software engineer as a result of a major new product development. The client is looking for an experienced and talented software engineer with experience of C++ and/or 'C' programming, MS-WINDOWS and STRUCTURED METHODOLOGIES. Ideally candidates will also have worked on Database, Real-Time or Communications based applications.

WINDOWS 3.0/SDK

City £23,5000
A major player in the rapidly expanding market of Imaging Systems, our client currently requires a senior programmer to aid in the development of their Image Management Tools. Candidates must have at least 18 months development experience using Windows 3.0/SDK together with knowledge of UNIX and/or PC Networking which would prove advantageous. An excellent opportunity to progress your career!!

This is a small percentage of our current 'C', C++ and WINDOWS vacancies. These skills are constantly in demand by our clients and requirements are generated on a daily basis throughout the UK. For an up-to-date view of what opportunities exist for you, call:-

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**WINDOWS SDK - C - SQL
ORACLE - RDBMS**

LEICS

TO 25K

Good Windows and OOP skills are the necessity with this role. Image processing software house with a view on many different platforms want a really good coder/developer who enjoys what he/she is doing. A good educational standard is required - a bright and numerate individual please.

**PRESENTATION MANAGER
OS/2 - C**

W.LONDON

20K + BENS

A graduate Software Engineer is wanted for a heavy duty financially orientated development. You should have a thorough understanding or experience of the development lifecycle. Structured methodologies play an important part in this company's programming strategy.

**DOS - OS/2 - WINDOWS
UNIX - OSF MOTIF**

BERKS

18-25K + BENS

A graduate is required with at least three years' experience in programming or on-line documentation technology, or one-line help systems. A self starter and a capable finisher is the kind of motivated individual required. This company has a reputation second to none and as such would improve any professional coders status instantaneously!! Oh, and any Hypertext experience would be greatly received.

SYBASE - C - X-WINDOWS

CITY

NEG + SUBSTANTIAL BENS

This is a typically nineties cocktail; you must be a high calibre developer with a good degree. Some knowledge of Banking Systems or broking would be an advantage. Futures or Equities experience would be the icing on the cake. For the right person the remuneration package will most likely be exceptional.

SMALLTALK - OOD - OOP - C

LONDON/HOME COUNTIES

27K + CAR

A platform independent development software house that has all the makings of doing extremely well: Quite a young company that requires a Coder/Developer with flair and ability. In profile you should be a second jobber with about two years' development ability behind you.

**MS-WINDOWS - X-WINDOWS - C
PC - UNIX**

N.LONDON/HERTS

TO 30K + BENS

Vertical market business/financial software house is looking for a systems/utility style programmer who can think both open Systems and networked PCs at the same time. You must be able to apply windows development skills to both platforms at any given moment: quite a challenging role for the right person; good experience.....

**RUN TIME SYSTEMS - 8086/286
DOS - OS/2 - UNIX**

BERKS

18-25k + BENS

Windows, and C Coding as well? This company doesn't want too much does it?! This development role is system programming in nature specifying, designing, coding and modifying products. Motivation is a prerequisite; experience of large systems development and a quality conscious attitude are all important traits.

**DIST/COOP PROCESSING
3720 EMULATION
MULTIPLE PLATFORMS**

BUCKS

35K

GUI Front end development; in a fast path project, a blinding coder is required for all elements in development life cycle: preferred knowledge is DOS OS/2, C and Cobol and some experience of LU2/3270 emulation; graphical interfaces and Dialog systems - CICS or IMS.....

**COMPILER - RUN-TIME
SYSTEMS - WINDOWS/NT**

BUCKS

18-25K

A Cobol run-time is written in C; to address and exploit all 32-Bit Operating Systems; such as Unix, OS/2 and Windows/NT. The job will involve all aspects of development, and cross platform consistency will be the ground rules; 2-3 years' systems programming experience on Unix, DOS, OS/2 or Windows is essential; and a creative approach to problem solving - small team work.....



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If any of the above vacancies do not quite suit you, why not give us a call and we might have just the right vacancy for you! For further information and applications, please call Mike Dearing or Simon Gudgeon on 071 321 2277, or after business hours and weekends on 0376 348469, alternatively fax your C.V. on 071 925 2150.

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Admral	Application Builder	399	49
Bits per Second	Graphics Tools	397	47
Blink Inc.	Clipper Fast Linker	400	50
BL Computer Security	Software Security Dongle	414	79
Brent Communications	MAX Copy Protection	409	71
Contemporary	BASIC Database	391	38
CTL	Copy Protection Hardware	410	71
Deepak Sareen	Project Management	385	32
DES	Software Protection	413	77
Expotech I	Programming Tools	382	26
Expotech II	Programming Tools	402	55
Forté Software Tools	Version Control	396	47
Grey Matter	Programming Tools	371	5
GWI	Software Design Tools	416/7/8	37
Inmark	C++ Application Framework	419	OBC
Inn Data	Development	392	40
Inst. Analysts/Progrms	Institute	408	71
Instrumatic	C++ Development	388	35
Intasoft	Software Management System	393	41
LPA	AI/KB/OOPS Software	386	35
Magnifeye	Software Protection Device	394	43
Microcosm	Copy Control	411	71
Microft	Security Software	405	62
Nu Mega	Debugging Tools	383	29
POET	Poet/Object Oriented Database	370	2

ADVERTISER	PRODUCT/SERVICE	CIRCLE	PAGE
Protek I	Programming Tools	377	17
Protek II	Programming Tools	401	53
QA	Training	415	IFC
QBS I	Editor	375	14
QBS II	Clipper	395	44
Rainbow Technologies	Security Products	378	19
Readmar	Version control	381	25
Richfords	Training	368	7
Ridgeway	Computer Manuals & Printing	387	35
Salford Software	Fortran for DOS & UNIX	376	15
Silica Systems I	Hardware	373	11
Silica Systems II	Hardware	369	IBC
SoftDev 92	Exhibition/Seminar	369	12/13
Softlok	Piracy Protection	412	75
Software Con Co. I	Visual Basic	379	20
Software Con Co. II	Programming Tools	406	65
Software Security	Security Products	372	8
System C	Application Generator	403	56
System Science I	Programming Tools	390	37
System Science II	Programming Tools	407	67
System Star I	TBX Shield	380	23
System Star II	Programming Tools	384	31
User Friendly	Software Copy Control	398	48
Zinc	GUI Library	404	61

Shakespeare on Programming

Wysiwyg has noticed some details in the Bard's works which seem to have escaped all previous Lit Critters.

Few people realise that, in addition to writing plays, William Shakespeare was an accomplished programmer and software beta-tester. His PC was configured 'with all appliances and means to boot' [*Henry IV* 2, III.1.29], and he also used a Macintosh, as evidenced by the remark, 'What light through yonder window breaks?' [*Romeo and Juliet* II.2.1] - uttered before he found the brightness control.

Structured programming was not Shakespeare's forte. *Troilus and Cressida*, written in FORTRAN for a Japanese car firm, contains the regrettable line 'Go to, go to!' [II.2.53] as well as fifteen other go tos, two go froms, and the inevitable comment, 'And whither go they?' [I.2.2]. A similar comment, 'Stand not upon the order of your going / But go at once' [*Macbeth* III.4.29] clearly refers to a multi-level exit from deeply nested procedures.

Shakespeare liked user-defined data types because, as he put it, 'There are more

things in heaven and earth, Horatio, than are dreamt of in your philosophy' [*Hamlet* I.5.166]. Elsewhere he asks, 'Shall I compare thee to a summer's day?' [*Sonnets* 18.1] - an obvious type mismatch, which is why he 'did never sonnet for her sake compile' [*Love's Labour's Lost* IV.3.134].

As a beta-tester for Borland, Shakespeare cautioned Philippe Kahn, 'Les langues des hommes sont pleines de tromperies' [*Henry V*, V.2.118], and advised him to bring out a fast, low-cost Pascal compiler, for 'I am as poor as Job, my lord, but not so patient' [*Henry IV* 2, I.2.145]. Many early Borland products were based on Shakespeare's suggestions, including SideKick ('A calendar! a calendar!' [*Midsummer Night's Dream* III.1.55]) and Turbo Prolog (with 'much virtue in "if"', As *You Like It* V.4.108).

Shakespeare disparaged BASIC on the ground that its designers 'have been at a great feast of languages, and stolen the

scraps' [*Love's Labour's Lost* V.1.39], though exactly which SIGPLAN banquet he had in mind is not clear. He later wrote a book on Modula-2, *Much Ado About Nothing*, and a list of bugs in PC-DOS 3.2, the *Comedy of Errors*. In the latter he tells a programmer, 'We may pity, though not pardon thee' [I.1.97]. Elsewhere he describes how DOS crashes with a stack overflow: 'He dies, and makes no sign' [*Henry VI* 2, III.3.29] and gives his advice to a colleague to whom this happened: 'Boot, boot, Master Shallow' [*ibid.*, V.3.141].

EXE

Wysiwig is a graduate of Cambridge University who was once left alone for an hour with a Shakespeare concordance. This article first appeared in PC Techniques and is reprinted with permission.

Verity Stob, who incidentally was from her mother's womb / Untimely ripped, is on holiday.

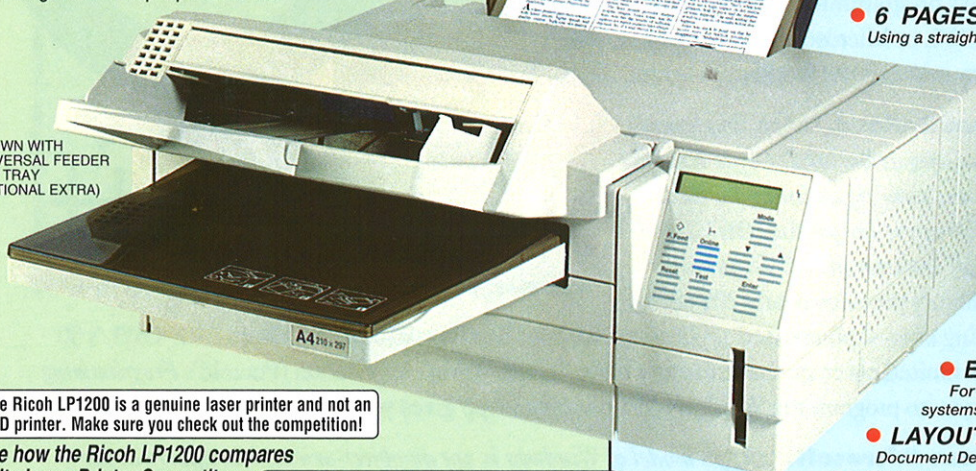
RICOH PCL5 LASER PRINTER

Ricoh UK Ltd is part of the worldwide Ricoh Group of companies, originally established in Japan, in 1936. With a turnover of over \$5 billion and 37,000 employees, Ricoh have been producing computers and peripherals since 1971 and are the world's second largest manufacturer of Laser Printer engines. Ricoh have employed their expertise to produce a 'first' in laser printers for the world market, the LP1200 with FLASH ROM.

Fully HP LaserJet III™ compatible, the new LP1200 employs industry proven laser technology. Unlike LED page printers, which use light emitting diodes, the LP1200's laser lightsource, focussed by high quality lenses, is able to produce the most accurate and intense printed images. It has 2Mb of RAM built-in and requires no additional RAM to print a full A4 page of graphics at 300dpi. Its fast, efficient processor and engine, together with a straight paper path design, allows printing at a full 6 pages per minute. Unlike its competitors, this advanced laser engine enables the LP1200 to address a range of print resolutions up to 400dpi. A special driver, combined with the 2Mb RAM upgrade, enables the Ricoh LP1200 to print at 400dpi from Windows 3.

Again, unlike the competition, the LP1200 includes a powerful document description language as standard. This language, 'LAYOUT', offers unique opportunities to develop custom-made printing systems. Forms and document templates can be designed and stored electronically in the LP1200's FLASH ROM, alleviating the need for pre-printed forms!

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(OPTIONAL EXTRA)



The Ricoh LP1200 is a genuine laser printer and not an LED printer. Make sure you check out the competition!

See how the Ricoh LP1200 compares to its Laser Printer Competitors

FEATURES	EPSON EPL4100	HP L/JET III	M'MAN TALLY MT904+	IBM 4029 Model 010	RICOH LP1200
Average Street Price (excl. VAT) (**expected)	£569	£699	£699*	£750	£699
Official RRP (excl. VAT)	£945	£1,179	£1,099	£1,099	£1,195
Maximum resolution in dots per inch	300 x 300	300 x 300	300 x 300	300 x 300	400 x 400
Windows 3 Driver @ 400 dpi	-	-	-	-	YES
Print Speed	6ppm	4ppm	4ppm	5ppm	6ppm
Straight Paper Path	YES	-	-	-	YES
PCL 5 Printer Command Language	-	YES	YES	-	YES
HP-GL/2 Vector Graphics included	-	YES	YES	YES	YES
Resolution Improvement/Enhancement	YES	YES	YES	YES	YES
Standard RAM	0.5Mb	1Mb	1Mb	1Mb	2Mb
Full A4/300 dpi graphics with standard RAM	-	-	-	-	YES
Warm Up Time	<45 secs	<60 secs	60 secs	33 secs	45 secs
First Page of Text Output	<20 secs	<40 secs	34 secs	20 secs	<15 secs
Document Description Language included	-	-	-	-	YES
Flash ROM	-	-	-	-	YES
Upgradable Firmware	-	-	-	-	YES
IC Card Slot	YES	-	-	YES	YES
Scalable Resident Fonts - in HP LJ III Emulation	-	8	8	0	8
Resident Bit-Mapped Fonts	11	14	14	16	14
AGFA Intelligent Scalable Font Technology	-	YES	-	-	YES
HP LaserJet III Emulation Included	-	YES	YES	-	YES
EPSON FX Emulation Included	YES	-	YES	-	YES
IBM ProPrinter Emulation Included	-	-	YES	-	YES
Standard Tray Capacity	100	70	100	200	100
Protective cover on standard tray	YES	-	YES	YES	YES
Cost per copy**	1.65p	2.00p	1.71p	1.64p	1.65p
Min-Max Paper Weight in gsm	60-157	60-105	60-120	60-131	60-157
Ability to print on OHP Film	YES	YES	YES	YES	YES
Ability to print on card (157gsm - Manual Feed)	YES	-	-	-	YES
Standby - Noise Level	<40dB	31.7dB	<35dB	38 dB	<38dB
Printing - Noise Level	<50dB	43.3dB	<46dB	50 dB	<48dB

**As quoted by manufacturers - 2/4/92

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FULLY HP LASERJET III™ COMPATIBLE

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Silica Systems are pleased to introduce the revolutionary, new Ricoh LP1200. It has all of the specifications that you would expect to see in today's most technically advanced laser printers, plus a unique additional feature which places it far ahead of the competition - FLASH ROM. This 'Future Proof' technology protects the investment you make when you buy a Ricoh LP1200, as it enables you to keep up to date with new laser firmware developments. FLASH ROM is an area of memory inside the LP1200 which holds the printer's controller instruction firmware. If new firmware is developed, updated printer command languages etc, can be downloaded into this memory. Other manufacturers would require you to buy a new printer! Fonts, macros, graphics and additional emulations can also be stored in FLASH ROM, or on removable, industry standard FLASH ROM IC cards. The new Ricoh LP1200 is the only laser printer to offer this FLASH ROM facility. The LP1200 comes with a 100 sheet A4 paper tray and the facility to feed single sheets of paper and card up to 157gsm. An optional extra universal feeder provides the facility to feed up to 150 sheets, from a minimum size of 98mm x 148mm to a maximum size of 216mm x 356mm at weights up to 158gsm, up to 15 envelopes, overhead transparencies and labels automatically.

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CODE	PRODUCT	PRICE Exc VAT
CAB 7500	Cable for PC/ST/Amiga	£8.47
LAA 5238	Universal Feeder (2nd Tray)	£100.00
LAA 5262	2Mb RAM Module	£149.00
LAA 5210	Developer/Toner Cartridge	£65.00
LAA 5225	OPC Cartridge (Drum)	£89.00
LAA 5312	A4 paper Tray (100 Sheets)	£35.00

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*Note: A4 paper tray is already included in the £699 price. More trays can be purchased to feed different coloured stationery.

LP1200 WITH SINGLE BIN & 2Mb RAM SILICA PRICE:

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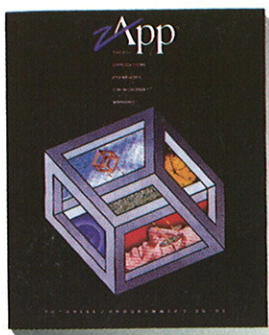
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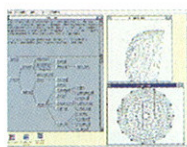
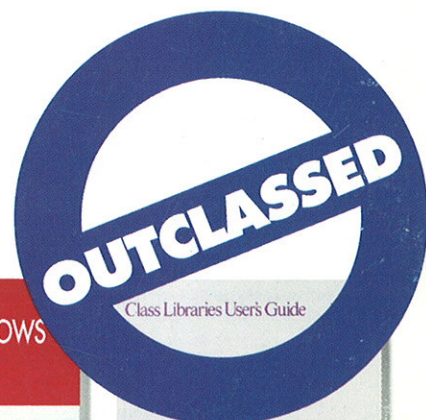
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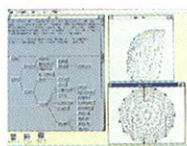
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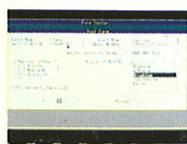
WORLD CLASS



WINDOWS 3.X



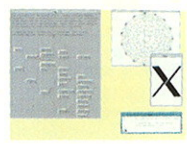
WINDOWS NT



DOS



OS/2 2.0



UNIX X/MOTIF

If you want an Application Framework that will simplify Windows programming, zApp is better than Borland's OWL or Microsoft's MFC. And zApp's portability makes it the world class leader.

zApp outclasses Borland. "zApp...implements the same general concepts as Borland's Object Windows (Library), but takes them significantly further... The zApp class library is larger than OWL's and much richer."—Jeff Duntzman, *PC Techniques*.

The zApp class library provides nearly 200 object classes for creating even sophisticated applications without hassling with the Windows API. OWL's 50 classes have such limited coverage that creating a basic "Hello World" application (Petzold's *Programming Windows*) forces you to program the Windows API directly. zApp gives you *all* the classes you need.

zApp outclasses Microsoft. "zApp's model of Windows is not an object-oriented wrapper (as in Microsoft's Foundation Classes)... Rather, zApp offers the most comprehensive, object-oriented approach I've seen to Windows."—Richard Hale Shaw, *Windows Tech Journal*. If you want an Application Framework to free you from grappling with the hard-to-use Windows API, zApp does it better than MFC. In fact, Richard Hale Shaw points out that MFC "might as well be Windows" and the MFC Users Guide even admits that it is "really a direct C++ wrapping of the familiar C functions for Windows". Because zApp presents a more powerful interface to Windows, zApp can reduce your code length by over 60% compared to MFC.

zApp gives you portability that OWL and MFC don't. With zApp, you can support multiple platforms today and know that your code will run on the platforms of tomorrow. zApp provides you with single source code compatibility between Windows™, Windows NT™, DOS, OS/2™, and soon, X/Motif™.

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